

HINDI MAHAVIDYALAYA, NALLAKUNTA, HYDERABAD
(AUTONOMOUS)
B.Sc. I Year Semester – I
Chemistry Paper I

Code: BS106

Instruction

Theory Classes

Practical Classes

Credit for Theory

Credit for Practical

Duration of Semester Examination

Duration of Internal Examination

Semester Examination Marks

Internal Marks

DSC – 3A

4 Hrs/Week

3 Hrs/Week

4

1

2 ½ hours

15 minutes

70 Marks

30 Marks

Unit-I (Inorganic Chemistry)

S1-I-1. P-Block Elements 1

Group-13: Structure of diborane and higher Boranes (B_2H_6 and B_3H_8), Boron nitrogen compounds ($B_3N_3H_6$ and BN), Lewis acid nature of BX_3 .

Group – 14: Carbides-Classification – ionic, covalent, interstitial – Structures and reactivity. Industrial applications. Silicones – Classification – straight chain, cyclic and cross-linked.

Group – 15: Nitrides – Classification – ionic, covalent and interstitial. Reactivity – hydrolysis. Reactions of hydrazine, hydroxyl amine, phosphazenes.

S1-I-2. General Principles of Inorganic Qualitative Analysis

Anion analysis: Theory of sodium carbonate extract, classification and reactions of anions- CO_3^{2-} , Cl^- , Br^- , SO_4^{2-} , PO_4^{3-} , BO_3^{3-} , CH_3COO^- , NO_3^- . Interfering ions. Cation Analysis: Principles involved - Solubility product, common ion effect, general discussion for the separation and identification of group I individual cations (Hg_2^{2+} , Ag^+ , Pb^{2+}) with flow chart and chemical equations. Principle involved in separation of group II & IV cations. General discussion for the separation and identification of group II (Hg^{2+} , Pb^{2+} , Bi^{3+} , Cd^{2+} , Sb^{3+} , III (Al^{3+} , Fe^{3+}), IV (Mn^{2+} , Zn^{2+}) individual cations with flow chart and chemical equations. General discussion for the separation and identification of group V individual cations (Ba^{2+} , Sr^{2+} , Ca^{2+}) with flow chart and chemical equations. Theory of flame test. Identification of Group VI cations (Mg^{2+} , NH_4^+).

Unit - II (Organic Chemistry)

S1-O-1: Structural Theory in Organic Chemistry

Bond polarization: Factors influencing the polarization of covalent bonds, electro negativity – inductive effect. Application of inductive effect (a) Basicity of amines (b) Acidity of carboxylic acids (c) Stability of carbonium ions. Resonance - Mesomeric effect, application to (a) acidity of phenol. (b) acidity of carboxylic acids and basicity of anilines. Stability of carbo cations, carbanions and free radicals. Hyper conjugation and its application to stability of carbonium ions, free radicals and alkenes.

15 h (1 hr/week)

7 h

8 h

15h(1 hr/week)

5 h

real gases, critical temperature and critical state. The van der Waal's equation and critical state. Derivation of relationship between critical constants and van der Waal's constants. The law of corresponding states, reduced equation of states. Joule Thomson effect and inversion temperature of a gas. Liquifaction of gases: i) Linde's method based on Joule Thomson effect ii) Claude's method based on adiabatic expansion of a gas.

S1-P-2: Liquid State and Solutions

6 h

Liquid State Intermolecular forces, structure of liquids (qualitative description). Structural differences between solids, liquids and gases. Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solutions Liquid - liquid mixtures, ideal liquid mixtures, Raoult's and Henry's laws. Non ideal systems. Azeotropes: HCl-H₂O and C₂H₅OH - H₂O systems. Fractional distillation. Partially miscible liquids: Phenol - Water, Trimethyl amine - Water and Nicotine - Water systems.

S1-P-3: Solid state Chemistry

4 h

Laws of Crystallography: (i) Law of Constancy of interfacial angles (ii) Law of Symmetry Symmetry elements in crystals (iii) Law of rationality of indices. Definition of space lattice, unit cell. Bravais Lattices and Seven Crystal systems (a brief review). X-ray diffraction by crystals; Derivation of Bragg's equation. Determination of structure of NaCl, KCl and CsCl (Bragg's method and Powder method).

Unit - IV (General Chemistry)

15h(1 hr/week)

S1-G-1: Atomic structure and elementary quantum mechanics

3 h

Black body radiation, heat capacities of solids, Rayleigh Jeans law, Planck's radiation law, photoelectric effect, Limitations of classical mechanics, Compton effect, de Broglie's hypothesis. Heisenberg's uncertainty principle. Quantum numbers and their significance.

S1-G-2. Chemical Bonding

7 h

Ionic solids- lattice and solvation energy, solubility of ionic solids, Fajan's rule, polarity and polarizability of ions. VSPER Theory - Common hybridization-sp, sp², sp³, sp³ d, sp³ d² and sp³ d³, shapes of molecules. Molecular orbital theory: Shapes and sign convention of atomic overlapping, σ and π orbitals. Modes of bonds. Criteria for orbital overlap. LCAO concept. Concept of Types of molecular orbitals- bonding, antibonding and non bonding. MOED of homonuclear diatomics - H₂, N₂, O₂⁻, O₂²⁻, F₂ (unhybridized diagrams only) and heteronuclear diatomics CO, CN⁻, NO, NO⁺ and HF. Bond order, stability and magnetic properties.

S1-G-3. Isomerism

5 h

Isomerism: Definition of isomers. Classification of isomers: Constitutional and Stereoisomers - definition and examples. Constitutional isomers: chain, functional and positional isomers. Stereoisomers: enantiomers and diastereomers - definitions and examples. Representation of stereoisomers - Wedge, Fischer projection, Sawhorse, Newmann formulae.

Conformational analysis : Classification of stereoisomers based on energy. Definition and examples Conformational and configurational isomers. Conformational analysis of ethane, nbutane, 1,2- dichloroethane, 2-chloroethanol. Cyclic compounds: Baeyer's strain theory, Conformational analysis of cyclohexane Cis-trans isomerism: E-Z-Nomenclature.

References

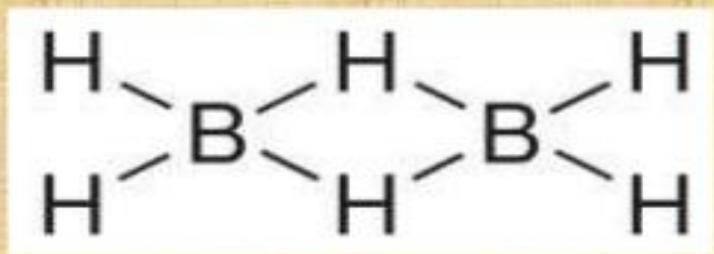
General reference: B.Sc I Year Chemistry : Semester I, Telugu Academy publication, Hyd

Unit- I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications 1996.

2. Concise Inorganic Chemistry by I. D. Lee 3rd edn

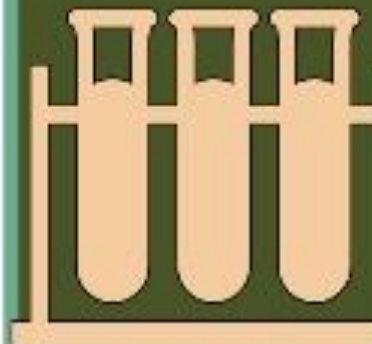
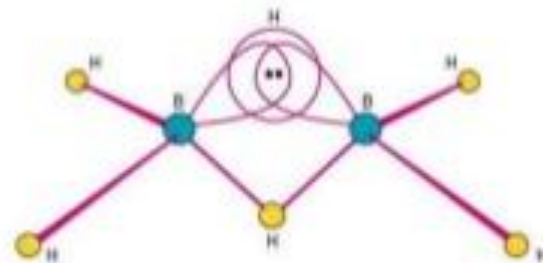
DIBORANE



STRUCTURE OF DIBORANE

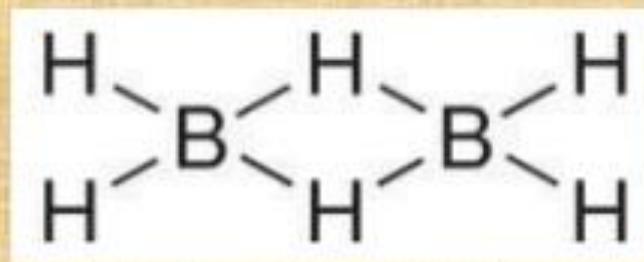
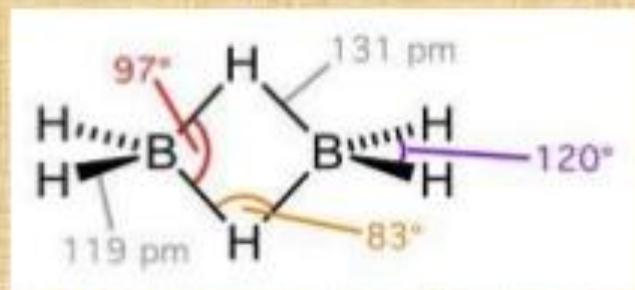
The structure of Diborane molecule consists of four hydrogen atoms and that of two boron atoms coming on the same plane. In between these planes, there are said to be two dividing atoms of hydrogen.

The boron atom is known to be sp^3 hybridized and has four hybrid orbitals. From these four hybrid orbitals, three of the orbitals have one electron each, and of which one is an empty orbital. The two electrons of the hybrid orbitals in each of the boron atoms form 2 bonds with the 1s hydrogen atoms. The two atoms of boron left with that of each unpaired electron orbital and empty orbital forms the two bridging (B-H-B) bonds with that of the two 1s hydrogen atoms, is also called as the banana bond.



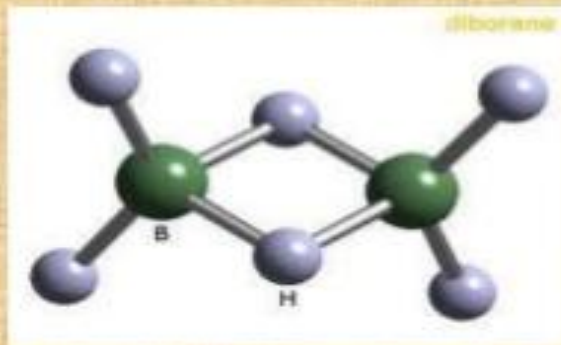
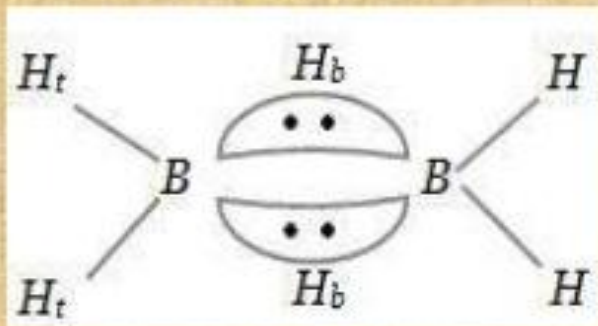
STRUCTURE OF DIBORANE

- X-ray diffraction has shown the following structure of diborane



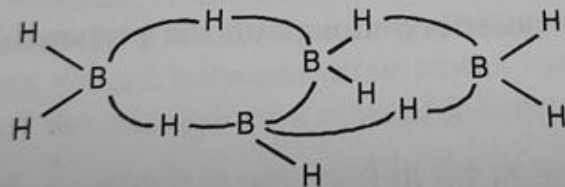
- Here B atoms undergo sp^3 hybridization. There are four terminal $B-H_t$ normal covalent bonds which are quite strong and two bridge $B \cdots H_b \cdots B$ which are different from normal covalent bonds and are quite weak

- As there are 12 electrons and 8 bonds in B_2H_6 molecule it is an electron deficient molecule
- Because of their resemblance to a banana these are also called banana bonds shown in the structure.



- Hence diborane molecule has two electrons less than the maximum required number thus it is an electron deficient molecule

Structure and bonding. The molecular formula of tetraborane (10) is B_4H_{10} . Its structure has been deduced from X-ray diffraction studies. In this structure, the bond angles are such that the boron skeleton can be considered to be either an octahedral or icosahedral fragment.



Structure of B_4H_{10} : ${}_5B.(1s^2 2s^2 2p^1)$ atom has three valence electron while ${}_1H(1s^1)$ has one valence electron. So, B_4H_{10} has total 22 valence electrons ($4 \times 3 + 10 \times 1 = 22$) which indicates



B4H10 structure

[en.m.wikipedia.org > wiki > Tetraborane...](https://en.m.wikipedia.org/wiki/Tetraborane)

Tetraborane - Wikipedia



About featured snippets



Feedback

People also ask

What is the formula of Tetraborane? How many bh2 units in b4h10 is? 

Planar view for the structure of **B₄H₁₀**. It can be clearly seen that there are four B–H–B bridges, no closed or bridging B–B–B unit, one B–B bond and two terminal **BH₂** groups. Hence, the overall STYX code for **B₄H₁₀** molecule is 4012.

[www.dalalinstitute.com > AT...](https://www.dalalinstitute.com)

PDF

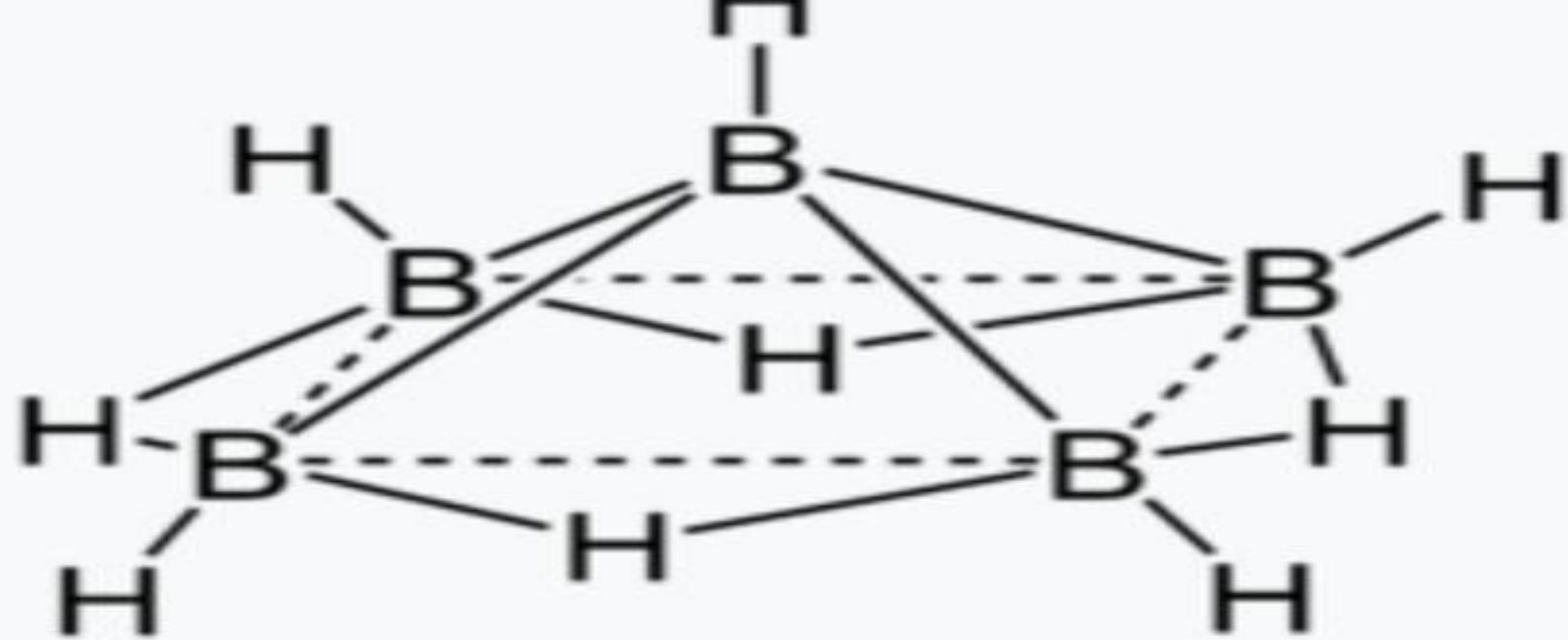
Structure and Bonding in

∨ History

∧ Structure

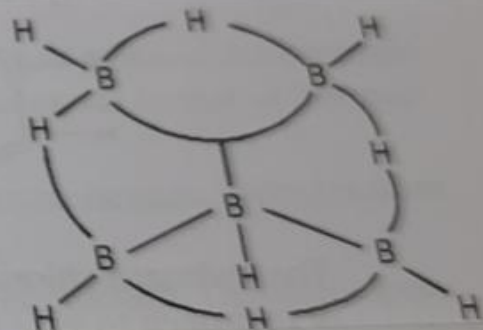
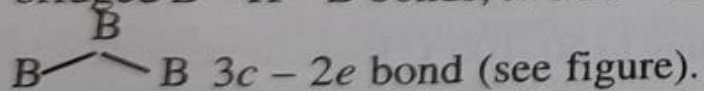


Like other [boranes](#), the structure of tetraborane involves multicenter bonding, with hydrogen bridges or protonated double bonds. According to its formula, B_4H_{10} , it is classified as an *arachno*-cluster and has a butterfly geometry, which can be rationalized by [Wade's rules](#).^[3] Each boron is sp^3 hybridized, and “the configuration of the three hydrogens surrounding borons B1 and B3 is approximately trigonal and suggests approximately tetrahedral hybridization for these borons which would predict bond angles of 120° .”^{[4]:35} However, the boron arrangements can be classified as fragments of either the





Structure of B_5H_9 : ${}_5\text{B}$ ($1s^2 2s^2 2p^1$) atom has three valence electrons, while ${}_1\text{H}$ ($1s^1$) atom has one valence electron. So, B_5H_9 has total 24 valence electrons which indicates 12 bonds. Out of these 12 bonds, there are five terminal $2c - 2e$, B - H bonds, four bridged B - H - B bonds, two $2c - 2e$ B - B bonds and one closed



Boron Nitride – Inorganic graphite



Boron Nitride – Inorganic graphite

Boron nitride is a chemical compound with chemical formula BN, consisting of equal numbers of boron and nitrogen atoms. BN is isoelectronic to a similarly structured carbon lattice and thus exists in various crystalline forms. The hexagonal form corresponding to graphite is the most stable and softest among BN polymorphs, and is therefore used as a lubricant and an additive to cosmetic products. The cubic variety analogous to diamond is called c-BN.

Boron nitride is not found in nature and is therefore produced synthetically from boric acid or boron trioxide. The initial product is amorphous BN powder, which is converted to crystalline h-BN by heating in nitrogen flow at temperatures above 1500 °C.

Because of excellent thermal and chemical stability, boron nitride ceramics are traditionally used as parts of high-temperature equipment. Boron nitride has a great potential in nanotechnology. Nanotubes of BN can be produced that have a structure similar to that of carbon nanotubes, a BN nanotube is an electrical insulator. Similar to other BN forms, BN nanotubes are more thermally

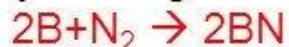
Boron nitride (BN)_n

It's a polymer of boron & nitrogen. Similar to graphite C_n & also iso electronic to it.

- Both B and N undergo sp² hybridisation. The hybrid orbitals of B & N overlap to form σ bonds while the remaining electrons form π-bonds
- The structure is similar to graphite C_n but the π- electrons are partially delocalized over B-atoms leading to unequal (B-N) bond lengths
- Each hexagonal ring has alternate single & double bonds with three boron and three nitrogen atoms
- The layers are so arranged that boron atom of one layer is immediately over the nitrogen atom of the adjacent layer
- B-N bond length is 1.45 Å while the distance between any two layers is 3.33 Å
- Boron nitride when heated to 3000°C at 70,000 atm pressure gives a cubic form like diamond structure where B & N attains a tetrahedral coordination. The (BN)_n in this form is superior to

Preparation of Boron nitride

1. By heating boron in nitrogen, NO or NH₃



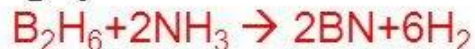
2. By heating B₂O₃ with Hg(CN)₂ KCN or NH₄Cl



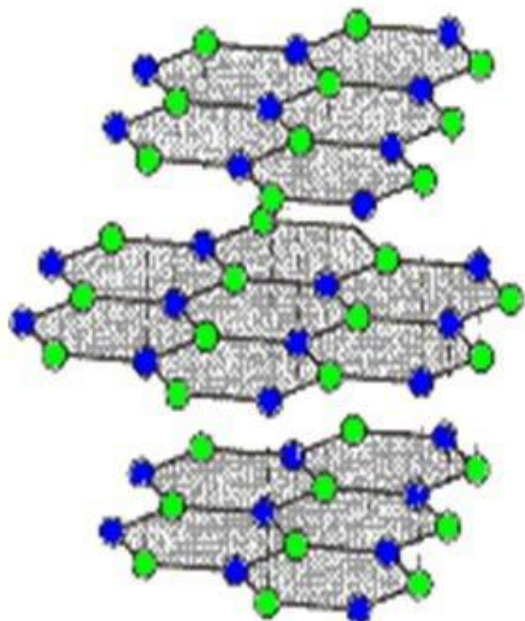
3. Anhydrous borax is heated with dry NH₄Cl to red heat in a platinum crucible



4. B₂H₆ reacts with excess of NH₃ at high temp, BN is obtained



Properties



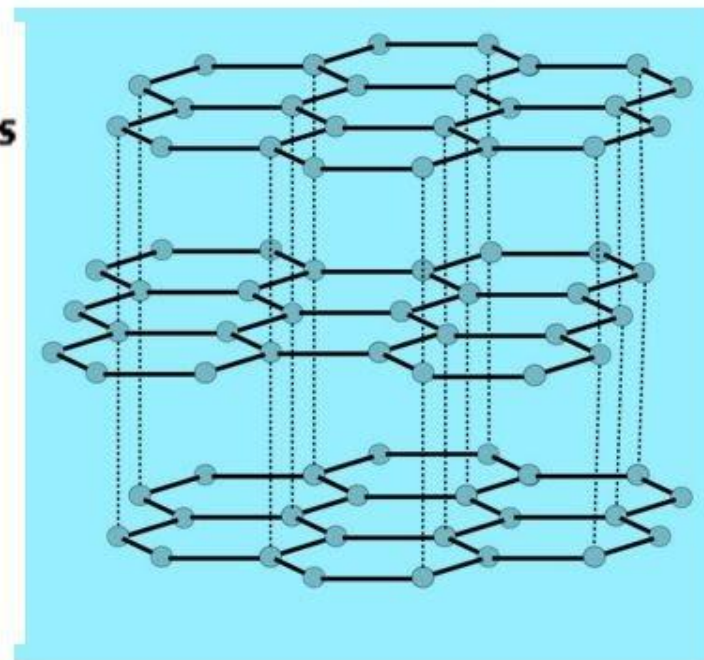
● boron atoms
● nitrogen atoms

hexagonal
form of
boron nitride

BN

(c) doc brown

BORON NITRIDE



GRAPHITE

Borazine or Borazole,
 $(\text{BH})_3(\text{NH})_3$ or $\text{B}_3\text{N}_3\text{H}_6$



- **Isoelectronic with benzene and hence as been called INORGANIC**

Structure of Borazine

Various chemical reactions and electron diffraction studies shows that Borazine is isoelectronic with Benzene and hence its structure is the same as that of Benzene.

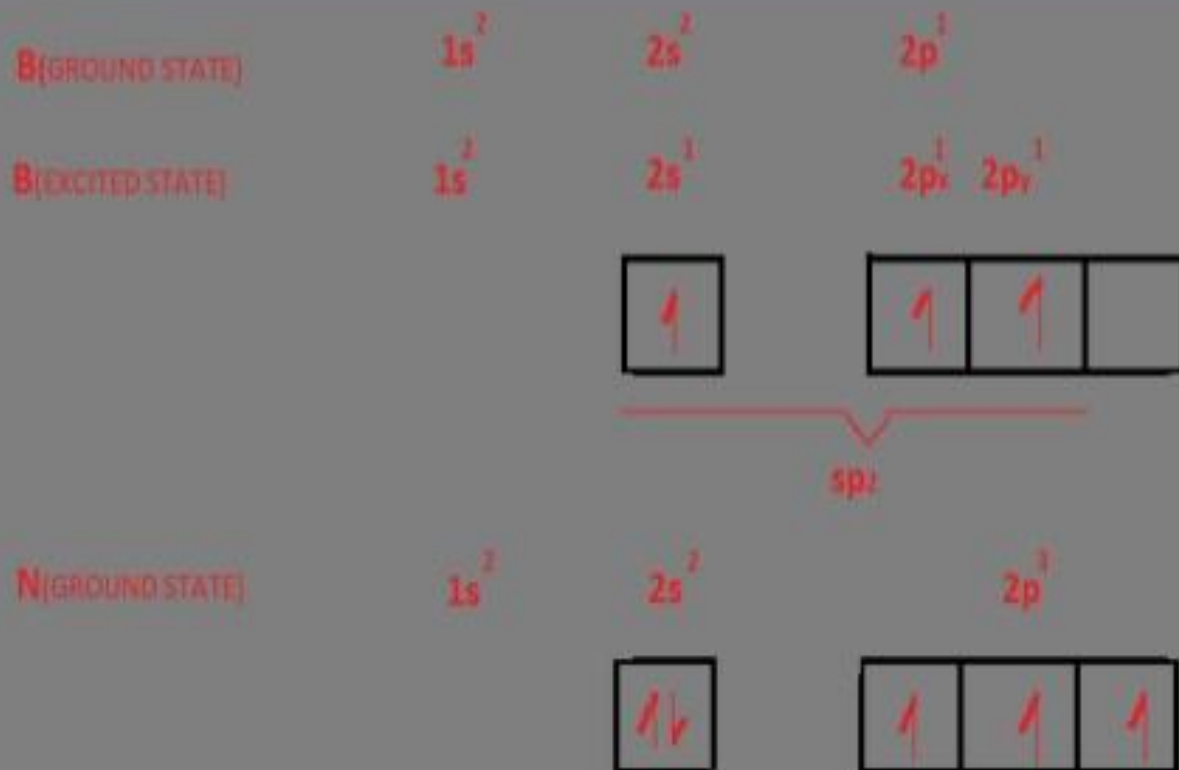
Like Benzene ,borazine has a planar hexagonal structure ,containing 6 membered ring , in which B and N atoms are arranged alternately

Because of the similarity between the structures of

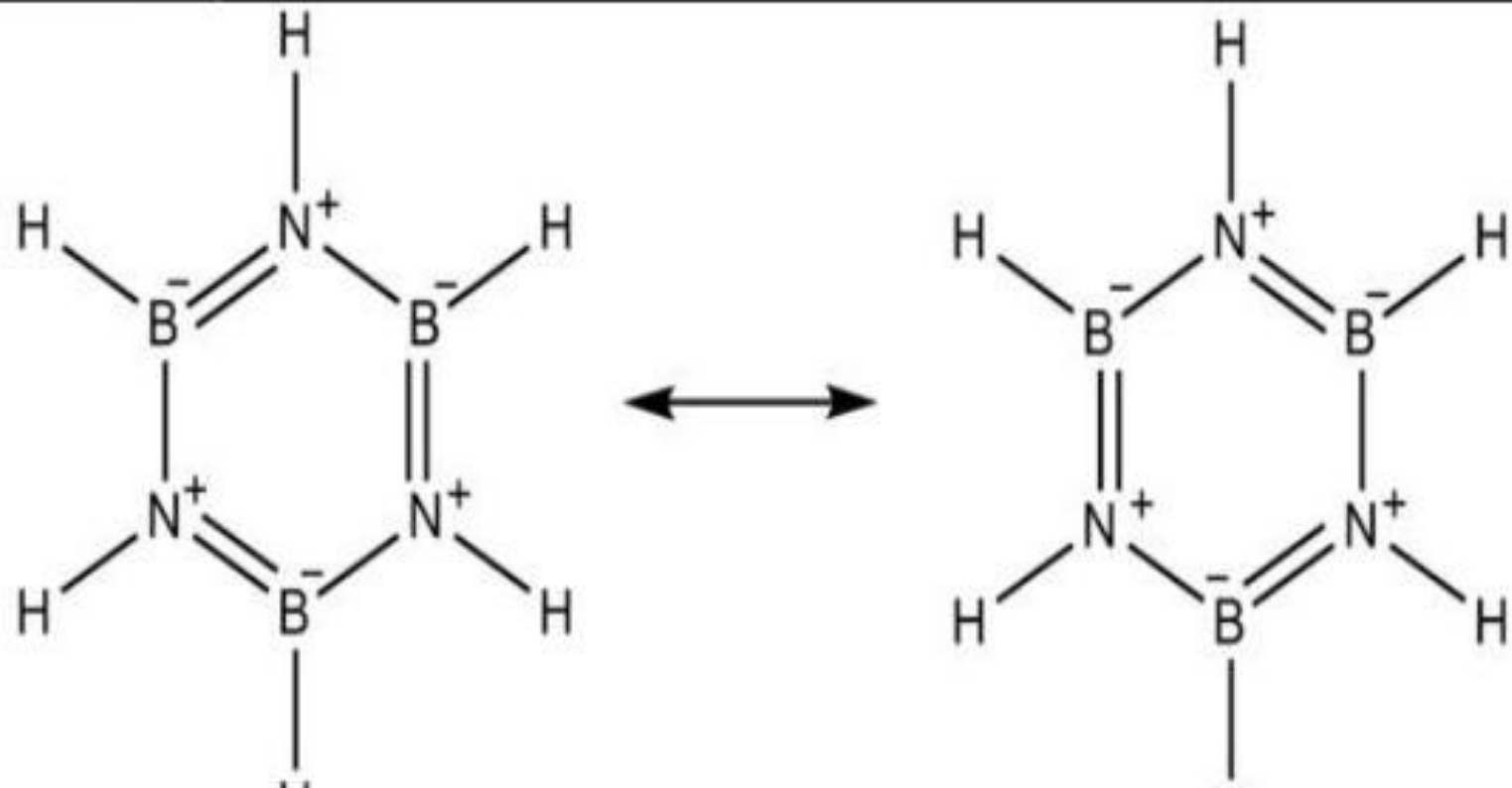
Structure of Borazine

- In Borazine both Boron and Nitrogen are sp^2 hybridised
- Each N-atom has one lone pair of electrons ,while each B-atom has an empty p-orbital.
- (B-N) π -bond in borazine is a Dative bond ,which arises from the sidewise overlap

Structure of Borazine



- Since borazine is isoelectronic with benzene, both the compounds have aromatic π -electron cloud.
- Due to greater difference in electronegativity values of B and N-atoms, the π -electron cloud in B₃N₃ ring of borazine molecule is partially delocalised (since N- π orbitals are of lower energy than the B- π orbitals)
- while in case of benzene ring, the π -electron



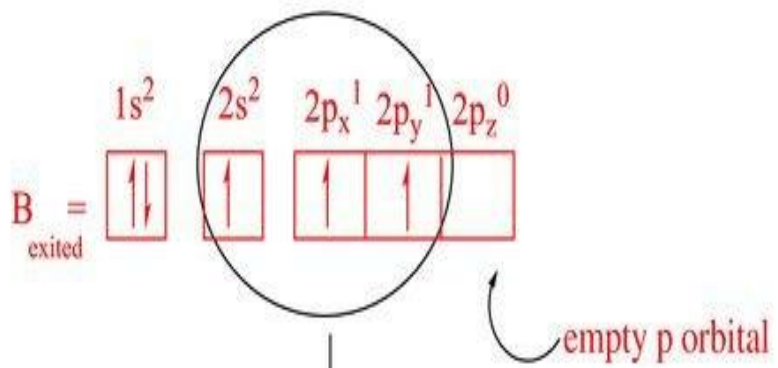
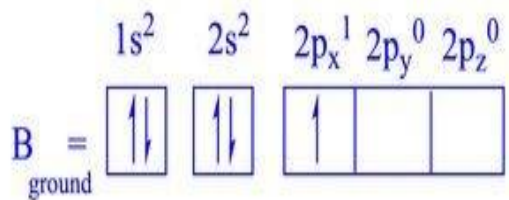
- M.O calculations have indicated that π -electron drift from N to B is less than the π -electron drift from B to N, due to greater electronegativity of N-atom.
- In benzene molecule, C=C bonds are nonpolar, while in case of B₃N₃H₆, due to the difference in electronegativities between B and N atom, B-N bond is polar.
- It is due to the partial delocalisation of π -electron cloud that π -bonding in B₃N₃ ring is weakend.

- N-atom retains some of its basicity and B-atoms retains some of its acidity.
- Polar species like HCl, therefore, attack the double bond between N and B. i.e why borazine in contrast to benzene, readily undergoes addition reaction.
- In borazine B-N bond length is equal to 1.44 \AA , which is between calculated single B-N bond (1.54 \AA)
- B=N bond length is 1.36 \AA
- The angles are equal to 120°

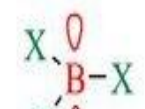
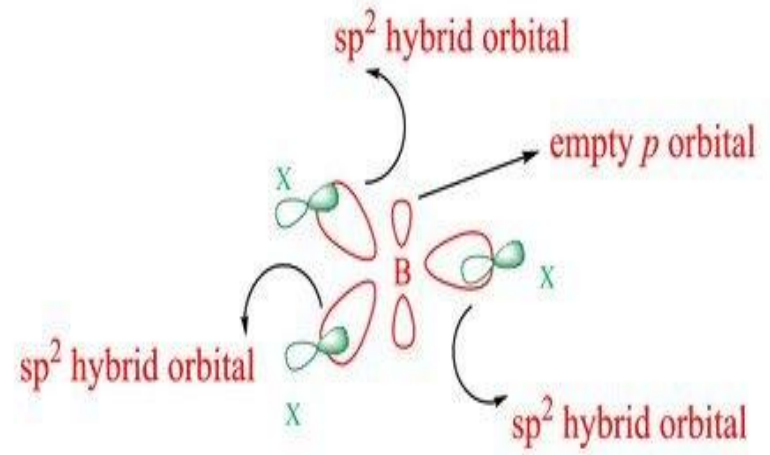
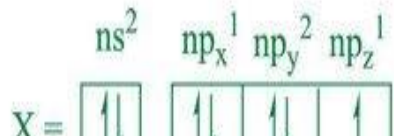
Lewis acid

contain an empty orbital
tendency to accept a pair of electron

How do you say that BX_3 is Lewis acid



sp^2 hybridization

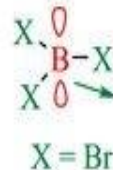
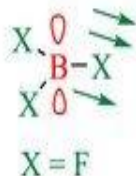


Electronegativity

attract bond pair of electrons towards itself



Electronegativity order of halogens



Therefore Lewis acid strength order suppose to be



But correct order of Boron trihalide as follows

