P-Block Elements

(IIIA Group Elements)

Short Answer Questions:

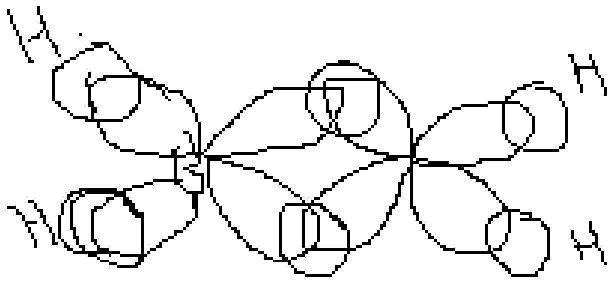
1. Explain the structure of Diborane?

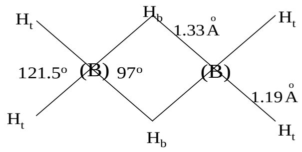
Ans. Diborane is an electron deficient compound. In diborane, total number of valence electrons is 12. diborane contains two coplanar BH_2 groups. Diborane has four terminal hydrogen atoms and the two boron atoms lie in one plane. Above and below this plane, there are two bridge hydrogen atoms. The bridge hydrogen atoms are present in a plane perpendicular to rest of the molecule. Each bridge hydrogen is bonded to the two boron atoms only by sharing of two electrons. These are called three centred two electron bonds, also known as banana or tau bonds.

In diborane, each boron atom in excited state undergoes sp^3 hybridisation. Two of the half filled sp^3 hybrid orbitals form sigma bonds with half filled 1s -orbitals of terminal hydrogen atoms. The third hybrid orbital containing unpaired electron overlaps simulta-neously with half filled

1s-orbital of bridge hydrogen atom and vacant hybrid orbital of the adjacent boron atom to constitute three centre two electron pair bond. Two such bonds are present in a diborane molecule two

B – H – B bond (sp^3 – s – sp^3).





The distance between the two non-bonded boron atoms is 177 pm.

2. Explain borax bead test with a suitable example?

Ans. On heating borax first gives sodium tetra borate and finally gives a mixture of sodium metaborate and B_2O_3 called borax glass. The boric anhydride B_2O_3 combines with metal oxides to form metal metaborates as coloured beads. This is known as borax bead test and is useful in the identification of basic radicals in qualitative analysis. The reactions are as follows:

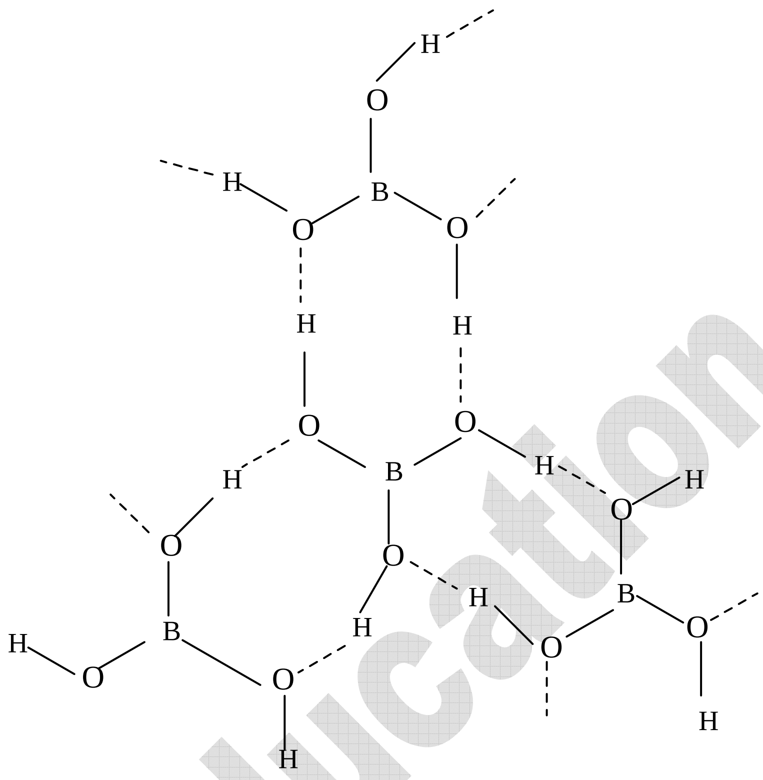
$$Na_2B_4O_7.10H_2O \rightarrow \underset{sodium\ metaborate}{Na_2B_4O_7} \xrightarrow{fused} \underbrace{2NaBO_2 + B_2O_3}_{(Borax\ glass)}$$

$$B_2O_3 + CoO \rightarrow \underset{Blue\ bead}{Co(BO_2)_2}\ (\text{Cobalt metaborate})$$

$$B_2O_3 + CuO \rightarrow \underset{green\ bead}{Cu(BO_2)_2}\ (\text{Copper metaborate})$$

3. Discuss the structure of Boric acid. Give its uses?

Ans. In boric acid, $B(OH)_3$ units are joined by hydrogen bonds to give two dimensional sheets. The sheets are held together by weak vanderwaals forces which are responsible for the cleavage of solid structure in to flakes.



The dotted lines represent hydrogen bonds.

Uses: boric acid is used

1. As an antiseptic
2. As a food preservative
3. In making enamel and glass.

4. Explain any two methods of preparation of diborane?

Ans. Preparation of diborane

1. Industrially diborane is prepared by the reaction of boron trifluoride with sodium hydride

$$2BF_3 + 6LiH \xrightarrow{450K} B_2H_6 + 6LiF$$

2. In laboratory, diborane is prepared by treating boron trifluoride with lithium aluminium hydride in anhydrous diethyl ether (OR) by the oxidation of Sodium borohydride with Iodine.

$$4BF_3 + 3LiAlH_4 \longrightarrow 2B_2H_6 + 3LiF + 3AlF_3$$

$$2NaBH_4 + I_2 \longrightarrow B_2H_6 + 2NaI + H_2$$

5. Write the reactions of B_2H_6 with

a) H_2O b) CO c) $N(CH_3)_3$

Ans. a. B_2H_6 readily reacts with water giving boric acid and hydrogen.

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$

b. It combines with carbon monoxide (Lewis base) to form borane carbonyl.

$$B_2H_6 + 2CO \longrightarrow 2\,BH_3.CO$$

c. It undergoes cleavage reactions with lewis base to form adduct

$$B_2H_6 + 2N(CH_3)_3 \longrightarrow 2BH_3.N(CH_3)_3$$

6. $Na_2B_4O_7 + Conc.H_2SO_4 \longrightarrow A \xrightarrow[ii.ignite]{1.C2H5OH} B(Greenedgeflame)$ **.Identify A and B?**

Ans. $Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$ **(A)**

$$H_3BO_3 + 3C_2H_5OH \xrightarrow{\Delta} (C_2H_5)_3BO_3 + 3H_2O$$

Here compound A is H_3BO_3 and B is $(C_2H_5)_3BO_3$

7. What happens when?

a. Borax is heated strongly

b. Boric acid is added to water

c. Aluminium is heated with dil-NaOH

d. BF_3 is treated ammonia.

Ans. a. On heating borax first gives sodium tetra borate and finally gives a mixture of sodium metaborate and B_2O_3 called borax glass.

$$Na_2B_4O_7.10H_2O \rightarrow \underset{sodium\ metaborate}{Na_2B_4O_7} \xrightarrow{fused} \underbrace{2NaBO_2 + B_2O_3}_{(Borax\ glass)}$$

b. Boric acid is not a protonic acid but acts as a Lewis acid by accepting electrons from a hydroxyl ion.

$$B(OH)_3 + HOH \longrightarrow [B(OH)_4]^- + H^+ \text{ (or)}$$

$$B(OH)_3 + 2HOH \longrightarrow [B(OH)_4]^- + H_3O^+$$

c. All reacts with dilute NaOH to form meta aluminate and liberates H_2 gas.

$$2Al + 2OH^- + 10H_2O \longrightarrow \underset{Meta\ aluminate\ ion}{2\left[Al(OH)_4(H_2O)_2\right]^-} + 3H_2\uparrow$$

d. BF_3 forms an adduct with Ammonia due to dative bond formation.

$$H_3N: + BF_3 \longrightarrow [H_3N:\rightarrow BF_3] \longrightarrow H_3N:BF_3$$

8. Write reactions to justify the amphoteric nature of aluminium.

Ans. Aluminium readily dissolves in dilute or concentrated hydrochloric acid liberating hydrogen.

$$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$$

Al reacts with dilute NaOH to form meta aluminate and liberates H_2 gas.

$$2Al + 2OH^- + 10H_2O \longrightarrow \underset{Meta\ aluminate\ ion}{2\left[Al(OH)_4(H_2O)_2\right]^-} + 3H_2\uparrow$$

As it reacts with both acid as well as base, it is said to be amphoteric in nature.

Very Short Answer Questions

1. What is the hybridisation of Boron in diborane and borazole?

Ans. Hybridisation of Boron in diborane is SP^3 and in borazole is SP^2.

2. What is inert pair effect?

Ans. The reluctance shown by pair of outer s–electrons in heavier p-block elements to participate in bond formationis called as inertpair effect.

Tl^{+1} are more stable than Tl^{+3} due to inert pair effect.

3. Give the formula of borazine. What is its common name?

Ans. The formula of borazine i.e borazole is $B_3N_3H_6$. It is commonly known as inorganic benzene as it is isostructral with benzene.

4. Give the formula of a) Borax b) colemanite.

Ans. The formula of borax is $Na_2B_4O_7.10H_2O$ and colemanite is $Ca_2B_6O_{11}.5H_2O$

5. It the structure of $AlCl_3$ as a dimer.

Ans.