HINTS & SOLUTIONS

p-Block Elements

[Set-2]

SECTION-A

1. (iii): In graphite C is sp^2 hybridised with % s-character of 33% and in diamond, C is sp^3 hybridised with % s-character is 25%

2. (iv): SiO_2 is an acidic, it is non-metal oxide and reacts with NaOH to form salt

$$SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$$

3. (iv): Bridged part of the diborane only contains 4 electrons, one each from boron atom and one each from hydrogen atoms.

4. (iii): BF_6^{3-} does not exist due to the non-availability of d-atomic orbitals in boron. Boron has a maxmum covalency of four.

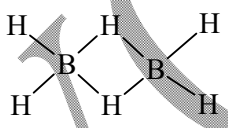
5. (ii): BF_4^- $B \rightarrow sp^3$

AlF_6^{3-} $Al \rightarrow sp^3d^2$

$B(OH)_3$ $B \rightarrow sp^2$

CO_2 $C \rightarrow sp$

6. (ii): Diborane does not have a boron-boron bond



Diborane is a Lewis acid and form an adduct with Lewis base, NH_3

$$B_2H_6 + 2NH_3 \longrightarrow B_2H_6.2NH_3$$

Both the statement are correct but reason is not the correct expansion for the assertion.

8. (iii) For lead, +4 oxidation state is not stable and it easily accepts two electrons to show + 2 oxidation state (inert pair effect). The species which accepts electrons is an oxidizing agent.

9. (iii): Down the group 13, stability of +3 oxidation state decreases and +1 oxidation state increases Ga shows +1 (GaCl) and +3 ($GaCl_3$) both

10. (iv): CO_2 is the strongest acid, C is most non-metallic and non-metallic oxides are acidic in nature.

11. (i) Gallium is much smaller in size than aluminium due to the presence of fully filled $3d^{10}$. Since d-subshell is highly diffused, has a poor shielding effect and is not able to protect the valence electrons from the nucleus effectively. So, all valence electrons are drawn towards the nucleus and tightly held. Hence, there is a contraction in size.

    (ii) Thallium has a fully filled $4f^{14}$ subshell present which has a poorest shielding effect. These 4f subshell is unable to protect the valence electrons. So, valence electrons are strongly held by the nucleus, and more energy is required to remove electrons. Hence, thallium has a higher ionization enthalpy than indium.

12. (i) Covalent

    Ionic, covalent

    (ii) Longer

OR

(i) $2NaBH_4 + I_2 \longrightarrow 2NaI + B_2H_6 + H_2$

(ii) $C(s) + H_2O(g) \xrightarrow{1270K} CO(g) + H_2(g)$

13. (i) Carbon has a strong tendency to catenate due to its small size and high carbon-carbon bond dissociation enthalpy.

    (ii) In CO_2, carbon complete its octet via $p\pi$-$p\pi$ bond formation as a result, CO_2 is a discrete molecule and the intermolecular forces of attraction are weak vander Waal forces. Hence, CO_2 is a gas. Due to large size, silicon cannot complete its octet via $p\pi$-$p\pi$ bonds. In order to complete its octet, each Si is σ bonded to four oxygen atoms and oxygen is σ bonded to two Si atoms. SiO_2 has a infinite three dimensional network structure. Hence, SiO_2 is a high melting solid.

    (iii) $[AlF_6]^{3-}$ exist but $[AlCl_6]^{3-}$ does not. This is due to small size of F.

    (a) Al can easily accomodate six F atoms in its corrdination sphere.

    (b) Al – F bond is stronger than Al – Cl bond.

14. (i) $B_2H_6 + 2NaH \longrightarrow 2Na^+[BH_4^-]$

    (ii) $2H_3BO_3 \xrightarrow[\text{strong}]{\text{heat}} 3H_2O + B_2O_3$

    (iii) $2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

OR

(i) Due to **inert pair effect**, lead shows both +2 and +4 oxidation states, Cl_2 being a strong oxidsing agent oxidises Pb^{2+} to Pb^{4+} to give $PbCl_4$.

$PbCl_2 + Cl_2 \rightarrow PbCl_4$

(ii) Due to intert pair effect, the stability of +2 oxidation state increases down the group. For Pb, + 2 oxidation state is more stable than +4. Therefore, $PbCl_4$ is unstable and decompose on heating to give $PbCl_2$ and Cl_2

$$PbCl_4 \xrightarrow{Heat} PbCl_2 + Cl_2$$

(iii) Since Pb^{4+} is less stable than Pb^{2+}, Pb^{4+} easily accepts electron and is a strong oxidizing agnet, Pb^{4+} oxidises I^- to I_2 and itself reduced to form Pb^{2+}.

$$PbI_4 \longrightarrow PbI_2 + I_2$$

This is an example of intramolecular redox reaction.

15. (i) (a) Its aqueous solution is alkaline so 'X' is a salt of strong base and weak acid.

(b) Since salt 'X' swells up to a glassy material Y, 'X' must be a borax and Y must be a mixture of sodium metaborate and boron oxide.

(c) On reaction with conc. H_2SO_4, white crystals of boric acid separates out

$X \rightarrow$ Borax, $Na_2B_4O_7.10H_2O$

$Y \rightarrow NaBO_2 + B_2O_3$

$Z \rightarrow H_3BO_3$

$$\underset{(X)}{Na_2B_4O_7.10H_2O} \xrightarrow{heat} Na_2B_4O_7 + 10H_2O$$

$$Na_2B_4O_7 \xrightarrow{heat} \underset{(Y)}{\boxed{2NaBO_2 + B_2O_3}}$$

$$\underset{(X)}{Na_2B_4O_7.10H_2O} + H_2SO_4 \longrightarrow Na_2SO_4 + 5H_2O + \underset{(Z)}{4H_3BO_3}$$

(ii) (a) Glass bottles contains SiO_2 which reacts with NaOH to form sodium silicate. So, glass dissolves in NaOH. Hence, NaOH solution cannot be stored in glass bottles,

$$2NaOH + SiO_2 \rightarrow Na_2SiO_3 + H_2O$$

(b) HF is used in the etching of glass because HF reacts with SiO_2 to form soluble H_2SiF_6

$4HF + SiO_2 \rightarrow SiF_4 + 2H_2O$

$SiF_4 + 2HF \rightarrow H_2[SiF_6]$

(soluble)

OR

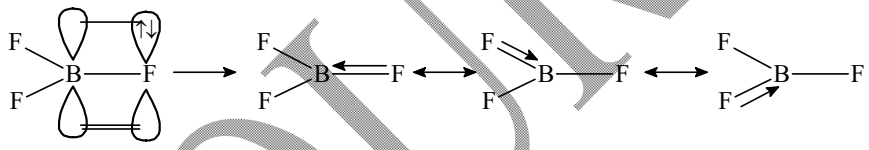
(i) Metal X is aluminium, dissolve in NaOH to give white precipitate of $Al(OH)_3$ which on reaction with excess of NaOH to give soluble $Na[Al(OH)_4]$. $Al(OH)_3$ also dissolves in HCl to give $AlCl_3$ and $Al(OH)_3$ on heating gives Al_2O_3 used to extract aluminium

$$\underset{(X)}{Al} + 3NaOH \longrightarrow \underset{\substack{(A)\\ \text{white ppt}}}{Al(OH)_3} + 3Na^+$$

$$\underset{(A)}{Al(OH)_3} + NaOH \longrightarrow \underset{(B)}{Na[Al(OH)_4]}$$

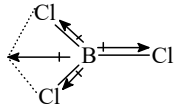
$$\underset{(A)}{2Al(OH)_3} \xrightarrow{Heat} \underset{(D)}{Al_2O_3} + 3H_2O$$

(ii) (a) BF_3 has a trigonal planar shape with boron sp^2 hybridised. Boron has one unhybridised 2p orbital which overlaps sideways with fully filled 2p orbital of F and form dative pπ-pπ bond. Due to double bond character, B – F bond length decreases



In BF_4^-, boron is sp^3 hybrisided with tetrahedral shape. Each B – F bond is a pure single bond and hence B – F bond is BF_4^- is longer than the B – F bond in BF_3.

(b) In BCl_3, each B – Cl bond is polar due to electronegativity difference and has a dipole moment. BCl_3 is a planar molecule, the resultant dipolemoment of two B – Cl bonds is cancelled by equal and opposite dipole moment of the third B – Cl bond. Hence, the overall dipole moment of BCl_3 is zero.



$\mu = 0$

