Miscellaneous Exercise Question Bank

1.(C) Hybridisation of $X = 2\sigma$ bonds + 1 lone pair = $3 \longrightarrow sp^2$

2.(A) CCl_4 has maximum covalent character. So, its melting point would be lowest. CCl is most ionic out of all four compounds. So it will have highest solubility in water.

3.(A) Larger the size of anion, higher will be its polarizability.

4.(D) Order of ionic size $\longrightarrow Li^+(aq) > Na^+(aq) > K^+(aq) > Cs^+(aq)$

5.(D) Larger the size of anion, more will be its polarisability & higher would be the covalent character.

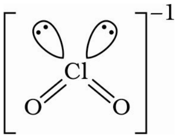
$\therefore$ Order of Anionic size $\rightarrow F^- < Cl^- < Br^- < I^-$

So, order of covalent character $\rightarrow CaF_2 < CaCl_2 < CaBr_2 < CaI_2$

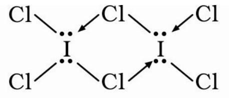
6.(A) F is the most electronegative element. So, HF will show

7.(D) Apply Fajan's rules. Smaller the size of cation and larger anion, more would be the covalent character.

8.(A) $ClO_2^- \rightarrow sp^3$ hybridisation

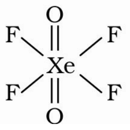


9.(D) $I_2Cl_6 \longrightarrow$



$\mu_{net} = 0$

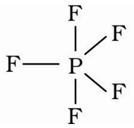
$XeO_2F_4 \longrightarrow$



$\mu_{net} = 0$

$Al_2Cl_6 \rightarrow$ structure similar to I_2Cl_6. So, $\mu_{net} = 0$

$PF_3Cl_2 \longrightarrow$

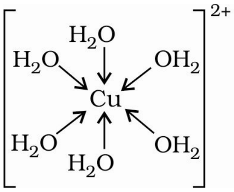


$\mu_{net} \neq 0$

10.(D) Hybrid orbits having more s-character are more electronegative because s-orbital is closer to the nucleus and hence, more attracted by the nucleus.

Thus, order of electronegativity $\rightarrow sp > sp^2 > sp^3$. Due to increase in electronegativity, bond angle increases and bond length decreases

11.(A)



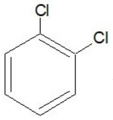
$[SO_4]^{2-}$

Coordinate bond : between cu^{2+} & H_2O

Covalent bond : between S & O atoms in SO_4^{2-}

Electrovalent bond : between $[Cu(H_2O)_5]^{2+}$ and SO_4^{2-}

12.(A) Excitation of 2s electron in N is not possible
Hence **(A)** is the correct answer.

13.(B) Except 

, the vector sum in each is zero

Hence **(B)** is the correct answer.

14.(C)

$CF_4 \rightarrow sp^3$	tetrahedral
$SF_4 \rightarrow sp^3d$	see-saw shape
$PCl_3 \rightarrow sp^3$	pyramidal
$BF_3 \rightarrow sp^2$	trigonal planar
$XeF_2 \rightarrow sp^3d$	linear
$CO_2 \rightarrow sp$	linear
$PF_5 \rightarrow sp^3d$	trigonal bipyramidal
$IF_5 \rightarrow sp^3d^2$	square pyramidal

15.(C) $KHF_2 \rightleftharpoons K^+ + HF_2^-$

Hence **(C)** is the correct answer.

16.(D) P in PO_4^{3-} has sp^3 hybridization like S in SO_3^{2-}

Hence **(D)** is the correct answer.

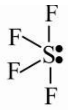
17.(B) Small cation has more polarising power
Hence **(B)** is the correct answer.

18.(C) Larger the ion, more is its polarisation
Hence **(C)** is the correct answer.

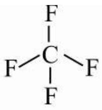
19.(A) Due to poor shielding effect of Ag^+, it has higher polarizing power

20.(C) In $NH_2(SiH_3)$, extent of Back Bonding is maximum so N–Si bond length is minimum

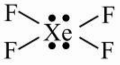
21.(D)



(SF_4)
See-SawShape



(CF_4)
Tetrahedral



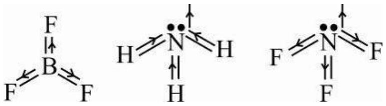
(XeF_4)
Square-Planar

22.(B)  SF_3^- shows bent T shape due to 3 Bond pair and 2 lone pair

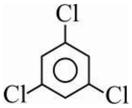
23.(C) The valence electrons Involved in the formation of covalent bond should be unpaired with opposite spin. (Refer VBT)

24.(C) Lattice energy can also be defined as the amount of energy required to break the solid ionic lattice into its gaseous constituent ions.

25.(B) BF_3 : dipole moment = 0



$BF_3 < NF_3 < NH_3$

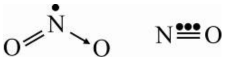
26.(C)  has zero dipole Moment.

27.(B) $\Delta x = 0.2$ (Δx = Electronegative difference)

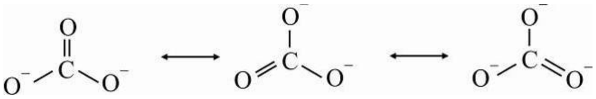
% Ionic character = $(16\Delta x + 3.5\Delta x^2)\%$

% Ionic character = $[16 \times 0.2 + 3.5 \times (0.2)^2]\% = (3.2 + 0.14) = 3.34\ \%$

28.(B) NO_2 and NO are paramagnetic due to presence of unpaired electrons.



29.(B) Bond order of CO_3^{2-} is 1.33



$$\text{B.O} = \frac{\text{Total no. of Bonds}}{\text{Total no. of Resonating Structures}} = \frac{4}{3} = 1.33.$$

30.(D) $O_2^- \longrightarrow 1$ unpaired electron $H_2^+ \longrightarrow 1$ unpaired electron

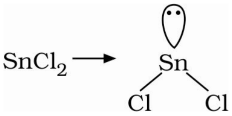
$O_2 \longrightarrow 2$ unpaired electron

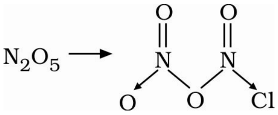
31.(B) $N_2 < O_2 < F_2 < Cl_2$ [size of Cl > F]
$N \equiv N \quad O = O \quad F - F \quad Cl - Cl$

32.(C) HF and CH_3OH will show intermolecular H-bonding

33.(D) In case of resonance structures,

- Arrangement of atoms should remain same
- Total no. of paired electrons are same
- No. of σ bonds are also same
- All of the structures should be of similar energy
- No. of unpaired electrons and π bonds may differ.

34.(A) 

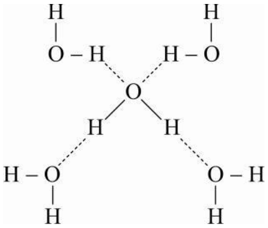
35.(B) 

36.(D) A crystal or crystalline solid is a solid material whose constituents (such as molecules, atoms or ions) are arranged in a highly ordered arrangement which provides a geometrical shape to the crystal.

$PCl_5 \rightarrow$ Has 10 electrons

$IF_7 \rightarrow$ Has 14 electrons

37.(D)



38.(A) Bond order of $O_2^+ = \frac{1}{2}[6-1]\frac{5}{2}$

Bond order of $N_2^+ = \frac{1}{2}[5-0] = \frac{5}{2}$

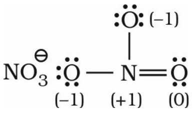
Hence **(A)** is the correct answer.

39.(C) B_2 (10 electrons) $\rightarrow K\ K^*\ L\ L^*\ \pi 2p_x^1\ \pi 2p_y^1$

O_2 (16 electrons) $\rightarrow K\ K^*\ L\ L^*\ \sigma 2p_z^1\ \pi 2p_x^1\ \pi 2p_y^2\ \pi^* 2p_x^1\ \pi^* 2p_y^1$

All other are diamagnetic molecules

40.(D) m-nitrophenol shows intermolecular H-bonding.

41.(C) 

42.(C) Electrovalent bond or ionic bond is non-directional in nature.

Covalent compounds, on the other hand, exhibit space isomerism.

43.(D) $A \rightarrow Mg$ (Valency = 2)

$B \rightarrow P$ (Valency = 3)

Compound formed is $A_x B_y$ or Mg_3P_2

So, $x + y = 5$

44.(C) E.G.E. in case of O^{2-}, N^{3-} & S^{2-} is +ve. So, ΔH_f is negative only due to highly negative Lattice energy of MgO, Li_3N and Na_2S.

45.(D) The molecules in which the central atoms have more than an octet of electrons in their valence shell are called as super octet molecules.

46.(A) bond polarity is directly related to difference of electronegativity of bonded atoms.

47.(D) $p_2 + p_z \xrightarrow{x-\text{axis}} \pi - \text{bond}$

$s + p_z \xrightarrow{x-\text{axis}}$ zero overlap

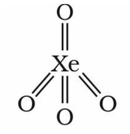
$s + p_y \xrightarrow{x-\text{axis}}$ zero overlap

48.(B) **(ii)** **(F)** In general as the number of lone pair electrons on central atom increases, value of bond angle from normal bond angle decrease due to $lp - lp > lp - bp$

(iv) **(F)** Structures of xenon fluorides and xenon oxy fluoride are explained on the basis of VSEPR theory.

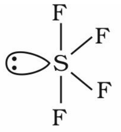
In $SOBr_2$, S — O bond has maximum bond length in comparison to S—O bond lengths in SOF_2 and $SOCl_2$ because in $SOBr_2$, S—O bond has been formed by hybrid orbital containing less s-character.

49.(C) **(A)**



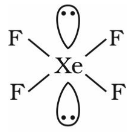
Non-polar
Non-planar

(B)



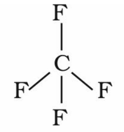
Polar
Non-planar

(C)



Non-polar
Planar

(D)



Non- polar
Non-planar

50.(C) Among the given solids, molecular solids are often soft substances with low melting points because the molecules are held together by intermolecular forces which are much weaker than bonds (metallic, ionic or covalent).

Eg. Dry ice, sucrose, sulfer, sugar etc.

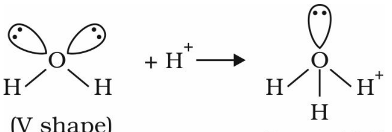
51.(C) CO, CO_2 and P_2O_5 are covalent compounds having their molecular lattice. But SiO_2 is a covalent compound having 3-dimensional network structure and it has covalent lattice, so M.P. of SiO_2 is maximum.

52.(D) In case of CO_2, the forces that hold molecules together are weak dispersion forces and hence CO_2 is a gas.

On the other hand, SiO_2 forms a 3-dimersional network structure and has a covalent lattice.

Hence, it is solid at room temperature.

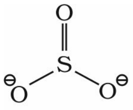
53.(B) During protonation hybridisation remain same but shape changes.

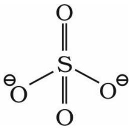


(V shape)
sp^3

(Pyramidal)
sp^3

54.(B)





B.O. $= \frac{4}{3} = 1.33$

B.O. $= \frac{6}{4} = 1.5$

$\left[\text{B.L.} \propto \frac{1}{\text{B.O.}}\right]$

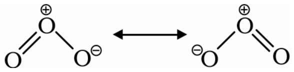
$\therefore \quad SO_3^{2-} > SO_4^{2-} > \underbrace{SO_2 > SO_3}_{\text{Bent's Rule}}$


B. o. = 2 B. o. =

55.(B) The least energy (E_3) structure contributes maximum to the resonance hyvrid.

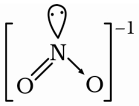
$\therefore \quad \text{Resonance energy} = E_0 - E_3$

56.(A) O_3 :



All other species do not contain any π electrons.

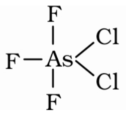
57.(B) Nitrite : $NO_2^{\ominus}$:



Angular in shape

Nitrile : RCN : $R-C\equiv N$ Linear in shape

58.(A) AsF_3Cl_2 :



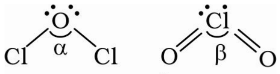
$\underline{\angle FAsF} = 90^{\circ}$

$\underline{\angle ClAsCl} = 120^{\circ}$

59.(B) Lattice energy is the amount of energy required to dissociate the solid ionic lattice into its gaseous constituents.

60.(D) Higher the electronegativity of the atom attached to the central atom, lesser will be the bond angle.

$\therefore \quad NF_3 < NH_3 \text{ and } PCl_3 > PF_3$



$\alpha < \beta$

61.(AD) Bond order can be fractional. Greater the bond order, greater is the bond dissociation energy.

62.(A) The boiling point of H_2 is least, so it is distilled first.

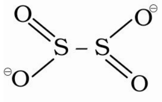
63.(A) Solid PCl_5 exists as an ionic compound –

$[PCl_4]^+ [PCl_6]^-$

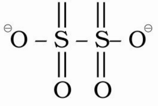
$[PCl_4]^+ \longrightarrow sp^3$

$[PCl_6]^- \longrightarrow sp^3d^2$

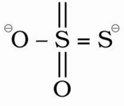
64.(D)



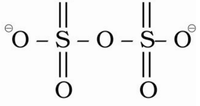
$S_2O_4^{2-}$



$S_2O_6^{2-}$



$S_2O_3^{2-}$



$S_2O_7^{2-}$

65.(D) Higher the charge on cation, more will be the polarization and more would be the covalent character. CF_4, SiO_2 and SiC are predominately covalent compounds.

66.(C) $N_2(14e^-): KK^*\ LL^*\ \pi 2p_x^2\ \pi 2p_y^2\ \sigma 2p_z^2$

$O_2(16e^-): KK^*\ LL^*\ \sigma 2p_z^2\ \pi 2p_z^2\ \pi 2p_y^2\ \pi^* 2p_x^1\ \pi^* 2p_y^1$

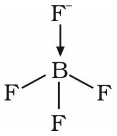
So, the electron is removed from the highest energy occupied MO.

67.(D) $N_2 \rightarrow$ Bond order = 3

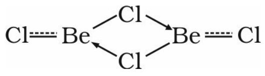
$N_2^+ \rightarrow$ Bond order = 2.5

So, N_2^+ has one unpaired electron and it is paramagnetic.

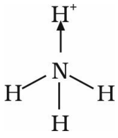
68.(B) **(A)**



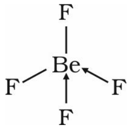
(B)



(C)



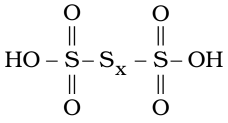
(D)



69.(B) $F(9): 1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$

So, each F atom has one unpaired electron in p-orbital (p_z orbital). So, F – F bond is due to the end-to-end overlap between the $p_z - p_z$ orbitals forming a sigma bond.

70.(B) Polythionic acid $(H_2S_nO_6;\ n > 2)$ is an oxoacid which has a straight chain of sulfur atoms.



$$HO-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-S_x-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$$

So, no. of S – S bonds = (n – 1)

71.(AC) $SF_6 \rightarrow$ O.S. of S is $+6$

Hybridisation $\rightarrow sp^3d^2$

shape $\rightarrow$ Octahedral

72.(BCD)

Ionic compounds are made up of ions primarily held together by strong electrostatic forces of attraction. Due to this, they have high melting and boiling points. They are highly soluble in polar solvents and form 3-d crystal lattices.

73.(ABC)

In case of BrF_3, SF_6 & IF_7, the central atom has more than 8 electrons in the valence shell.

74.(AB) $B_2: KK^*\ LL^*\ \pi 2p_x^1 = \pi 2p_y^1$

$C_2: KK^*\ LL^*\ \pi 2p_x^2 = \pi 2p_y^2$

O_2^{4-} : Bond order = 0

75.(AB) Since F is more electronegative than P, so the bond pair of electrons shift towards F. As a result, the bond angle in PF_3 increases.

76.(AC) In $(CH_3)_3N$ and $\overset{\ominus}{C}F_3$, C atom does not have d-orbital.

77.(ABC) O_2^- : Bond order = 1.5

NO : Bond order = 2.5

CO_3^{2-} : Bond order = 1.33

CO_2 : Bond order = 2

78.(AC) NO has one unpaired electron

NO : Total electrons : 15

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2\ \sigma 2p_z^2\ \pi 2p_x^1$

***79.(ABD)** **(A)** $NH_3 > PH_3 > AsH_3$

All are sp^3 hybridised. If side atom is same and central atom is different. As size of central atom increases, Bond angle decreases.

(B) $\underbrace{NH_3 > H_2O}\ \underbrace{> F_2O}$ Bond angle of $NH_3 > H_2O$ due to lone pair

$H_2O > F_2O$ (due to electronegativity)

(C) $NO_2^+ > NO_2^- > NO_2$ (Incorrect)

NO_2^+ : sp

NO_2^- : sp^2 $NO_2^+ > NO_2 > NO_2^-$ (Correct order)

NO_2 : odd e^-.

(D) $CH_4 > NH_3 > H_2O$ (due to lone pair)

80.(ABCD) In case of Group-II metal ions, lattice energy increases down the group while the hydration energy decreases.

81.(ABCD) Intermolecular H-bonding occurs when H is attached to a highly electronegative atom such as F, O or N.

82.(AC) Benzoic acid dimerises due to intermolecular H-bonding.

83.(ACD) $SeF_4 \longrightarrow sp^3d$ Trigonal pyramidal in shape

84.(AC) $s + p_z$: Non – bondig; $s + s : \sigma$ – bond; $p_z + p_x$: Non – bonding; $d_{xy} + p_y ; \pi$ – bond

85.(ACD) Mg^{2+}, N^{3-} form Mg_3N_2, X_3Y_2 type compound.

86.(A) Solubility of metal sulphates decreases down the group due to increase in lattice energy.

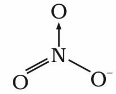
87.(B) Smaller cation causes more polarization of anion.

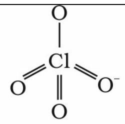
Hence **(B)** is the correct answer.

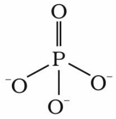
88. **(A)-r ; (B)-p ; (C)-s ; (D)-q**

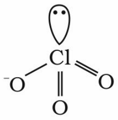
$BCl_3 : sp^2$, $NH_3 : sp^3$, $PCl_5 : sp^3d$, $XeF_4 : sp^3d^2$

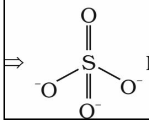
89. A → R; B → P, T; C → S; D → Q

⇒  B.O. of N — O = 1.33

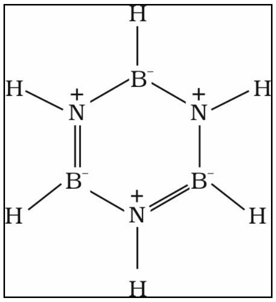
⇒  B.O. of Cl — O = 1.75

⇒  B.O. of P — O = 1.25

⇒  B.O. of Cl — O = 1.67

⇒  B.O. of S — O = 1.50

90. A → P, S, T; B → P, R, T; C → P, S, T; D → Q, S, T

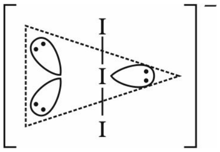
(A) 

→ Planar as both B and N are sp^2 -hybridized

→ $\mu_D = 0$ (non – polar)

→ has $2p_\pi - 2p_\pi$ back bonding between B — N bond.

→ has no co-ordinate bond

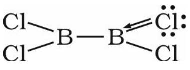
(B) 

→ Planar structure

→ $\mu_0 = 0$

→ has no back bond

$:\ddot{\underset{..}{I}}: - \ddot{\underset{..}{I}}: + :\ddot{\underset{..}{I}}: \rightleftharpoons :\ddot{\underset{..}{I}} - \underset{..}{I} \leftarrow \ddot{\underset{..}{I}}:$

(C) 

→ Planar structure as both B-atoms are sp^2 – hybridised

→ $\mu_0 = 0$

→ has $2p_\pi - 3p_\pi$ back bonding in B — Cl bond

→ has no co-ordinate bond

(D) $2P_{\pi} - 3d_{\pi}$ back bonding

$\rightarrow$ Non-planar

$\rightarrow$ $\mu_D = 0$

$\rightarrow$ has no co-ordinate bond

91. $\mathbf{A \rightarrow P, Q, R, S, T;}$ $\mathbf{B \rightarrow P, R, T;}$ $\mathbf{C \rightarrow Q, S, T;}$ $\mathbf{D \rightarrow P, R, T}$

(A) $p_x + p_x \xrightarrow[\text{overlap}]{\text{axisl}} \sigma \text{ Bonding} + \sigma \text{ Anti} - \text{bonding}$

$p_y + p_y \xrightarrow[\text{overlap}]{\text{sideways}} \pi - \text{bonding} + \pi - \text{Anti} - \text{bonding}$

$p_x + p_y \longrightarrow \text{zero overlap (Non} - \text{Bonding)}$

(B) $x + p_x \xrightarrow[\text{overlap}]{\text{axial}} \sigma - \text{Bonding} + \sigma \text{ Anti} - \text{bonding}$

$s + p_y \xrightarrow[\text{overlap}]{\text{non-axial}} \text{Non} - \text{bonding}$

(C) $d_{xy} + p_y \xrightarrow[\text{overlap}]{\text{Non-axial}} \text{Non} - \text{bonding}$

$d_{xy} + p_z \xrightarrow[\text{overlap}]{\text{Non-axial}} \text{Non} - \text{bonding}$

(D) $d_{z^2} + p_z \xrightarrow[\text{overlap}]{\text{axial}} \sigma - \text{Bonding} + \sigma\text{anti} - \text{bonding}$

$d_{z^2} + p_y \xrightarrow[\text{overlap}]{\text{axial}} \text{Non} - \text{bonding}$

92.(B) $d_{z^2} + p_y \longrightarrow \text{zero overlap}$

93.(C) Only d_{z^2} orbital is aligned along z-axis. p_x and p_y orbitals are perpendicular to z-axis. d_{zx} orbital lies in the xz plane.

94.(C) **(A)** $p_z + p_z \longrightarrow \pi - \text{bond}$

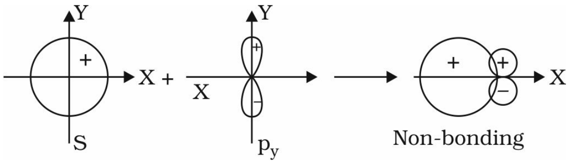
(B) $p_y + p_y \longrightarrow \pi - \text{bond}$

(C) $d_{z^2} + dxy \longrightarrow \text{Non} - \text{bonding}$

(D) $s + s \longrightarrow \sigma \text{ bond}$

95.(B) Bond dissociation energy : Cl — Cl > P — P > Si — Si

96.(A)



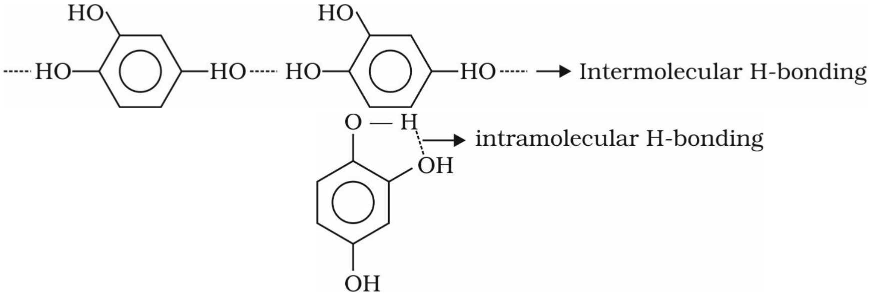
97.(C)

(A)	SO_3	No. of $p\pi - p\pi = 1$,	$p\pi - d\pi = 2$
(B)	NO_3^-	No. of $p\pi - p\pi = 1$,	$p\pi - d\pi = 0$
(C)	SO_4^{2-}	No. of $p\pi - p\pi = 0$,	$p\pi - d\pi = 2$
(D)	CO_3^{2-}	No. of $p\pi - p\pi = 1$,	$p\pi - d\pi = 0$

98.(D) → Halogens are non-polar species, hence London dispersion forces act among them and these forces are directly proportional to molecular weight.

→ London dispersion forces $\propto$ B.P. and M.P. in such non-polar species.

99.(D)



100.(A) → Boiling point of $HN_3 > CH_3N_3$ as in hydrazoic acid (HN_3) intermolecular H–bonding occurs and its bond energy is higher than weak dipole-dipole interactions present in CH_3N_3.

→ Boiling point of BI_3 is greater than that of BF_3 as molecular weight of BI_3 is higher than that of BF_3.

→ Due to intermolecular H-bonding in H_2SO_4 its boiling point is higher than Me_2SO_4.

→ Similarly due to intermolecular H-bonding in $B(OH)_3$ its boiling point is higher than that of Me_3BO_3.