CHEMICAL BONDING
SOLUTIONS
LEVEL – 1

IONIC BOND

1. An ionic compound A^+B^- is most likely to be formed when.
   (1) The ionization energy of A is high and electron affinity of B is low
   (2) The ionization energy of A is low and electron affinity of B is high
   (3) Both, the ionization energy of A and electron affinity of B are high
   (4) Both, the ionization energy of A and electron affinity of B are low
   There must be an overall decrease in energy, i.e. energy must be released. For this cation should have low Ionisation potential and anion should have high value of electron-affinity. This is the basic condition for formation of an electrovalent bond

2. Which of the following is an ionic compound?
   (1) SO_3 (2) ICl (3) KI (4) $CHCl_3$
   K is highly electropositive. Electronic configuration of K is 2, 8, 8, 1 and I is highly electronegative. Therefore they form an electrovalent or ionic bond.

3. The compound which does not contain ionic bond is
   (1) NaOH (2) HCl (3) K_2S (4) LiH
   In NaOH, Na is 2, 8, 1 and OH has -1 valency $\therefore$ Na donates 1 electron and OH accepts one electron. This is the case in each option $\therefore$ they form ionic compunds. But in HCl, both H and Cl are sharing electrons.

4. The magnitude of the lattice energy of a solid increase if
   (1) the ions are large (2) the ions are small
   (3) the ions are of equal size (4) charges on the ions are small
   Lattice energy is the amount of energy released when one mole of ionic solid is formed from its gaseous ions. The amount of energy released is due to electrostatic force of attraction.
   $F \propto \frac{q_1 q_2}{r^2}$ where r is the interionic distance and q1, q2 are magnitude of charges.
   $\therefore$ for max lattice energy, r should be minimum r will be small, if size of ion is small.

5. Which one of the following statements is incorrect?
   (1) Sodium hydride is ionic
   (2) Beryllium chloride is covalent
   (3) CCl_4 gives a white ppt. with $AgNO_3$ solution
   (4) Bonds in NaCl are non–directional

6. The compound which contains ionic as well as covalent bonds is
   (1) $C_2H_4Cl_2$ (2) CH_3I (3) KCN (4) H_2O_2
   Ionic bond id formed when electronegativity difference is very large i.e. between 1.7 to 3.2. Hence Ionic bond is formed between K and C and covalent bond is formed between C and N.

7. Which of the following is least soluble in H_2O?
   (1) BaF_2 (2) SrF_2 (3) CaF_2 (4) MgF_2
   Water is polar solvent and like dissolves like Be, Mg, Ca, Ba, Br, Ra are elements of group II A, and as we go down a group electronegativity decreases. Hence the least electropositive elements

are topmost elements i..e. Br, Mg is more electropositive than the other option, the bond between MgF_2 is highly polar.

8. Amongst LiCl, RbCl, $BeCl_2$ and $MgCl_2$, the compounds with the greatest and least ionic character respectively are
(1) LiCl and RbCl (2) RbCl and $BeCl_2$
(3) RbCl and $MgCl_2$ (4) $MgCl_2$ and $BeCl_2$
Compare these elements in the periodic table to find Rb is most electropositive and Be is least electropositive. Greatest Ionic character is seen when highly electropositive element reacts with highly electronegative element.

9. Which of the following is insoluble in water?
(1) AgF (2) AgI (3) KBr (4) $CaCl_2$
To be Insoluble in water, the solute should be non-polar I is more electropositive than F. $\therefore$ AgI is more non polar than AgF.

10. Which of the following is least ionic?
(1) AgCl (2) KCl (3) $BaCl_2$ (4) $CaCl_2$
For such questions, refer the periodic table and check electronegativities. To be least ionic the electronegativity difference between the metal and non-metal should be the least.

11. Which one is the highest melting point?
(1) NaCl (2) NaF (3) NaBr (4) NaI.
M.P. $\propto$ Lattice energy

12. Which of the following statements about LiCl and NaCl is wrong?
(1) LiCl has lower melting point that NaCl
(2) LiCl dissolves more in organic solvents whereas NaCl does not
(3) LiCl would ionise in water more than NaCl
(4) Fused LiCl would be less conducting than fused NaCl
LiCl has greater covalent character.

13. In which of the following species the bonds are non–directional?
(1) NCl_3 (2) RbCl (3) $BeCl_2$ (4) BCl_3
Overlapping does not take place in ionic bond. Rb is a metal present in group I(A) of periodic table.

14. The electrovalency of the element is equal to the –
(1) number of electrons lost
(2) number of electrons gained
(3) number of electron transferred
(4) number of electrons lost or gained by the atom of the element during the formation of ions of ionic compound
The number of electron gained or lost by an atom of an element is known as its electrovalency.

15. Ionic bond formation involves :
(1) Elimination of protons (2) Sharing of electrons
(3) Overlapping of orbitals (4) Completion of octets
In ionic bond formation the atoms lost or gain electrons to complete their octets.

16. The hydration of ionic compounds involves –
(1) Evolution of heat (2) Weaking of attractive forces
(3) Dissociation into ions (4) All

Hydration is an exothermic process.

17. Among the following which compounds will show the lowest lattice energy ?
(1) KF (2) NaF (3) CsF (4) RbF

Lattice energy $\propto \frac{1}{\text{size}}$ of the cation.

18. The lattice energy of the lithium is in the following order:
(1) LiF > LiCl > LiBr > LiI (2) LiCl > LiF > LiBr > LiI
(3) LiBr > LiCl > LiF > LiI (4) LiI > LiBr > LiCl > LiF

Lattice energy $\propto \frac{1}{\text{size}}$ of the cation.

19. Among LiCl, $BeCl_2$, BCl_3 and CCl_4, the covalent bond character follows the order :
(1) LiCl < $BeCl_2$ > BCl_3 > CCl_4 (2) LiCl > $BeCl_2$ < BCl_3 < CCl_4
(3) LiCl < $BeCl_2$ < BCl_3 < CCl_4 (4) LiCl > $BeCl_2$ > BCl_3 > CCl_4

20. Which one of the following show correct order of covalent character ?
(1) ZnO < ZnS (2) ZnS = ZnO (3) ZnS < ZnO (4) None

21. Lattice energy (LE) affects on :-
(1) Stability of ionic compound (2) Melting point of ionic compound
(3) Solubility of ionic compound (4) All of the above

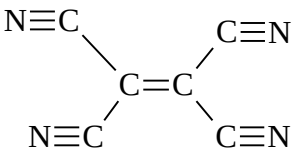
OCTET RULE AND COVALENT BOND

22. Which of the following compound does not follow octet rule?
(1) CO_2 (2) PCl_3 (3) ICl (4) ClF_3

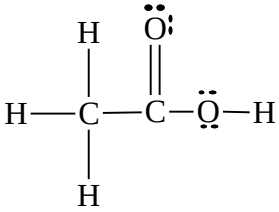
23. In NO_3^- ion, the number of bond pairs and lone pairs of electrons on nitrogen atom are
(1) 2, 2 (2) 3, 1 (3) 1, 3 (4) 4, 0

24. Which of the following statements concerning a covalent bond is false?
(1) The electrons are shared between atoms
(2) The bond is non–directional
(3) The strength of the bond depends upon the extent of overlapping
(4) The bond formed may be polar or non–polar.

25. The number of sigma (σ) and pi (π) bonds present in a molecule of tetracyanoethylene $(CN)_2C=C(CN)_2$ are
(1) 5σ and 9π (2) 5σ and 8π (3) 9σ and 9π (4) 9σ and 7π

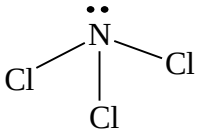


26. In the electronic structure of acetic acid, there are
(1) 16 shared and 8 unshared electrons (2) 8 shared and 16 unshared electrons
(3) 12 shared and 12 unshared electrons (4) 18 shared and 6 unshared electrons

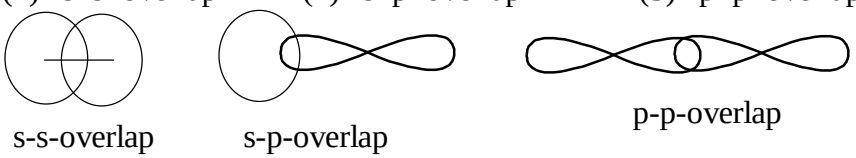


27. Which of the following is an example of super octet molecule?
(1) ClF_3 (2) PCl_5 (3) IF_7 (4) all the three
The total electrons surrounding the central atoms are more than 8 in all.

28. Which of the following has one lone pair of electrons on the central atom?
(1) H_2 (2) CH_4 (3) NH_4^+ (4) NCl_3



29. A covalent bond may be formed by
(1) s–s–overlap (2) s–p–overlap (3) p–p–overlap (4) all these three



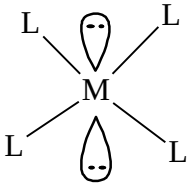
30. Lateral overlap of p–orbitals leads to the formation of
(1) π–bond (2) metallic bond (3) σ–bond (4) Ionic bond
Sideways overlap of p-orbitals lead to $\pi-$bonds.

31. The fluorine molecule is formed by
(1) p–p orbitals (sideways overlap) (2) p–p orbitals (end–to–end overlap)
(3) sp–sp orbitals (4) s–s orbitals
A $\sigma-$bond is formed between the two F-atoms by the overlap of their P-orbitals.

32. Which of the following will provide the most efficient overlap?
(1) s–s (2) s–p (3) sp^2–sp^2 (4) sp–sp
Hybrid orbitals with greater p-character form stronger bonds.

35. Two hybrid orbitals have a bond angle of 120°C. The percentage of s character in the hybrid orbital is nearly
(1) 25% (2) 33% (3) 50% (4) 66%
Sp^2 hybridisation has 120^0 bond angles.

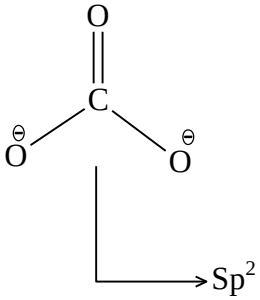
37. The molecule ML_x is planar with six pairs of electrons around M in the valence shell. The value of x is
(1) 6 (2) 2 (3) 4 (4) 3
Sp^3d^2 hybridsation



38. Atomic orbitals of carbon in carbon dioxide are
(1) sp – hybridised (2) sp^3d – hybridised (3) sp^2 – hybridised (4) sp^3 – hybridised

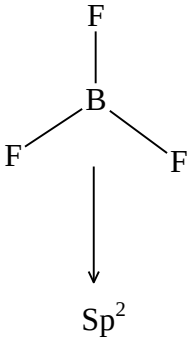
$O = C = O$
Sp

39. Which one is not tetrahedral?
(1) BF_4^- (2) NH_4^+ (3) CO_3^{2-} (4) SO_4^{2-}



40. On hybridization of one s and one p – orbitals , we get
(1) two mutually perpendicular orbitals (2) two orbitals at 180°
(3) four orbitals directed tetrahedrally (4) three orbitals in a plane.
Sp hybridization gives linear geometry.

41. The geometry and the type of hybrid orbitals present about the central atom in BF_3 is
(1) linear, sp (2) trigonal planar , sp^2
(3) tetrahedral , sp^3 (4) pyramidal , sp^3



42. The linear structure is assumed by
(1) $SnCl_2$ (2) C_2H_2 (3) NO_2 (4) SO_2

$H - \underset{\downarrow}{C} \equiv \underset{\downarrow}{C} - H$
Sp Sp

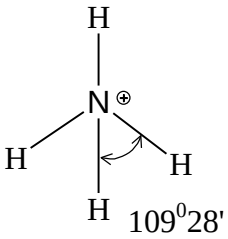
43. CO_2 is isostructural with
(1) HgI_4^- (2) $SnCl_2$ (3) NCO^- (4) NO_2

$:\ddot{O}=C=\ddot{O}:$ $:\ddot{N}=C=\overset{\Theta}{\ddot{O}}:$

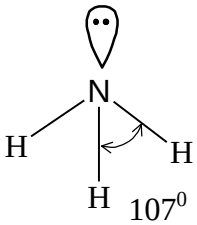
44. The bond angles of NH_3, NH_4^+ and NH_2^- are in the order

(1) $NH_2^- > NH_3 > NH_4^+$ (2) $NH_4^+ > NH_3 > NH_2^-$

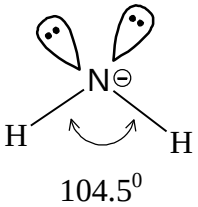
(3) $NH_3 > NH_2^- > NH_4^+$ (4) $NH_3 > NH_4^+ > NH_2^-$



$109^0 28'$



107^0

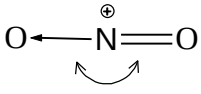


104.5^0

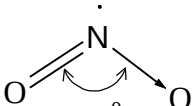
45. The correct order of bond angles is

(1) $NO_2^- > NO_2^+ > NO_2$ (2) $NO_2^+ > NO_2^- > NO_2$

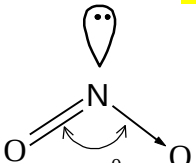
(3) $NO_2 > NO_2^+ > NO_2^-$ (4) $NO_2^+ > NO_2 > NO_2^-$



180^0



134^0



115^0

46. The bond angle in H_2S is

(1) $> NH_3$ (2) Same as in $BeCl_2$

(3) $> H_2Se < H_2O$ (4) Same as in CH_4

Bond angle decreases with the decrease in the electronegativity of the central atom

47. Which of the following set contains species having same angle around the central atom?

(1) SF_4, CH_4, NH_3 (2) NF_3, BCl_3, NH_3

(3) BF_3, NF_3, $AlCl_3$ (4) BF_3, BCl_3, BBr_3

All are sp^2 hybridised.

49. Which of the following pair does not have same shape?

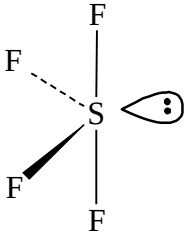
(1) NH_4^+, CH_4 (2) H_3O^+, NH_3 (3) I_3^-, XeF_2 (4) PF_5, BrF_5

PF_5 is trigonal bi pyramidal and BrF_5 is square pyramidal.

50. Which of the following does not have a tetrahedral structure?

(1) SO_4^{2-} (2) SF_4 (3) SO_2Cl_2 (4) SeO_4^{2-}

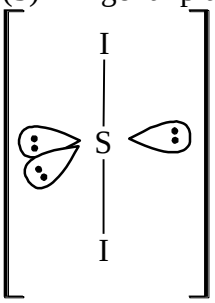
SF_4 is trigonal bipyramid.



51. The geometrical arrangement and shape of I_3^- are respectively

(1) Trigonalbipyramidal, T-shape (2) Octahedral, linear

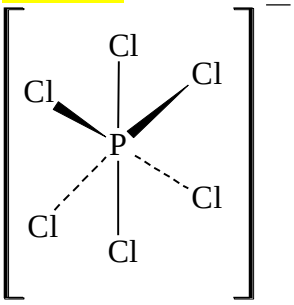
(3) Trigonal planar, Angular (4) Trigonalbipyramidal, linear



Arrangement is trigonal bipyramidal.

52. Which of the following is octahedral?

(1) PCl_6^- (2) SF_4 (3) BO_3^{3-} (4) BF_4^-



53. Which of the following have linear shape?

(1) $SnCl_2$ (2) NO_2^+ (3) FNO (4) SO_2

Calculate hybridization for each molecule

$NO_2^+ \rightarrow \frac{1}{2}[0+5-1] = 2 = \text{sp hybridization}$

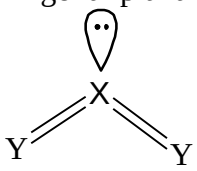
No. of lone pairs =0

$\therefore$ shape is linear.

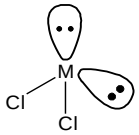
54. A molecule XY_2 contains two σ, two π bonds and one lone pair of electrons in the valence shell of X. The arrangement of lone pair as well as bond pairs is

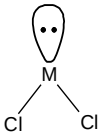
(1) Square pyramidal (2) Linear (3) Trigonal planar (4) Unpredictable

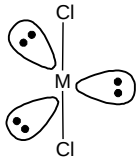
Trigonal planar



55. If the atomic number of M is 50. The shape of gaseous MCl_2 is

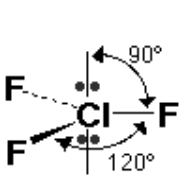
(1) 

(2) 

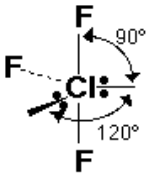
(3) 

(4) Cl——M——Cl

56. Select the correct order for the stability of given possible structures of ClF_3



(I)



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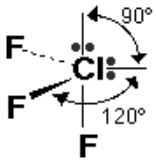


(III)

(1) I >II >III (2) III >II >I (3) II >I >III (4) III >I >II

Repulsion between

Lone – pair – lone pair > lone pair bond pair > Bond pair Bond pair

∴ III is least statble

57. In which of the following, bond angle is maximum?

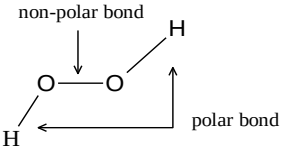
(1) NH_3 (2) NH_4^+ (3) PCl_3 (4) SCl_2

Presence of lone pairs on the central atom decreases the bond angles.

DIPOLE MOMENT

58. Which of the following pair contains both polar and non – polar bonds?

(1) NH_4Cl (2) HCN (3) H_2O_2 (4) CH_4



59. Among the following bonds which has the most polar character?

(1) C – O (2) C – Br (3) C – F (4) C – S

For most polar character, we find most electro-negative element from O, Br, F and S

E.N. decreases ↓ O F ↓ E.N. decreases

S Br

E.N. inc →

From periodic table

∴ F most electronegative

60. The molecule which has zero dipole moment is

(1) CH_2Cl_2 (2) BF_3 (3) NH_3 (4) ClO_2

BF_3 is trigonal planar and hence has zero dipole moment.

61. Which one of the following arrangement of molecules is correct on the basis of their dipole moments ?

(1) $BF_3 > NF_3 > NH_3$ (2) $NF_3 > BF_3 > NH_3$

(3) $NH_3 > BF_3 > NF_3$ (4) $NH_3 > NF_3 > BF_3$

In NH_3, the orbital dipole due to lone pair is in the same direction as resultant dipole moment of N – H bonds but in NF_3, the orbital dipole is in the direction opposite to resultant dipole moment of the 3 N – F bonds

62. Arrange the following compounds in order of increasing dipole moment. Toluene (I), m – dichlorobenzene (II), o – dichlorobenzene (III), p – dichlorobenzene (IV).

(1) I < IV < II < III (2) IV < I < II < III (3) IV < I < III < II (4) IV < II < I < III

Dipole moment increases with decrease in bond angles.

63. Which one of the following has zero dipole moment ?
(1) ClF (2) PCl_3 (3) SiF_4 (4) $CFCl_3$
SiF_4 has symmetrical structure

64. Which of the following compounds is non–polar?
(1) CH_3Cl (2) CH_2Cl_2 (3) $CHCl_3$ (4) CCl_4
CCl_4 has a symmetrical structure.

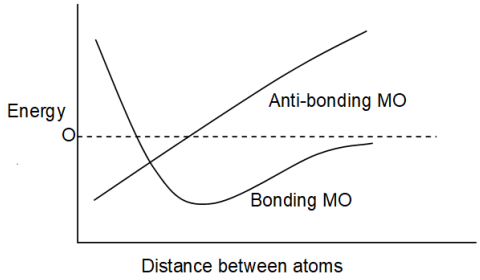
65. Which of the following molecules has highest dipole moment?
(1) H_2S (2) CO_2 (3) CCl_4 (4) BF_3

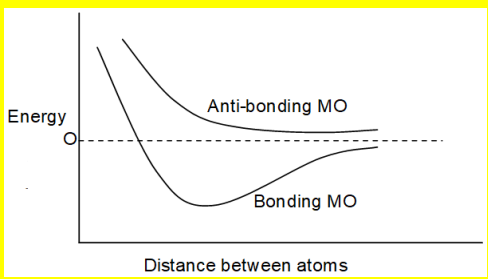
MOT

66. Which of the following diatomic molecules would be stabilized by the removal of an electron
(1) C_2 (2) CN (3) N_2 (4) O_2
Bond order of $O_2^+ > O_2$

67. When N_2 forms N_2^+, the N—N bond distance …….. and when O_2 forms to O_2^+, the O—O bond distance……..
(1) increases, decreases (2) decreases, increases
(3) increase in both case (4) decrease in both case
Bond order $\propto \frac{1}{\text{bond length}}$

68. Which graph best represent the energy diagram of molecular orbitals V/S distance between atoms

(1)


(2)


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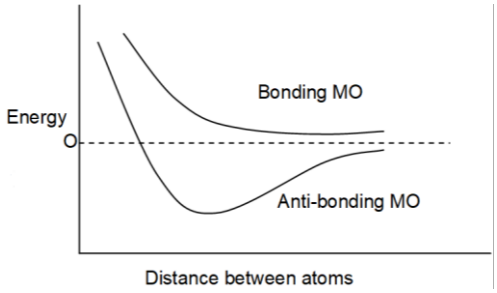

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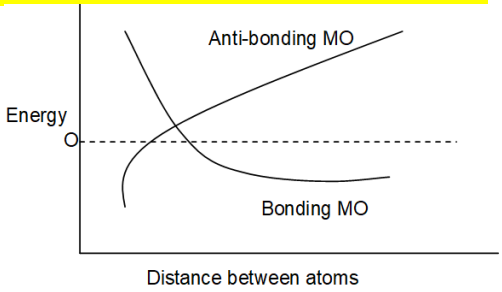


Bonding M.O. have lower energy than antibonding M.O

69. Which of the following statements is incorrect?
(1) He_2 does not exist because its bond order is zero
(2) O_2, O_2^- and O_2^+ are all paramagnetic
(3) any two atomic orbitals can combine to form two molecular orbitals
(4) $\pi(2p_x)$ and $\pi(2p_y)$ are degenerate molecular orbitals
For linear combination of atomic orbitals the combining orbitals should have comparable energies.

70. The bond order in peroxide ion $\left(O_2^{2-}\right)$ is

(1) 2.5 (2) 1.5 (3) 2 (4) 1.0

$$B.O = \frac{N_b = N_a}{2}$$

71. The energy of σ_{2s} is greater than σ_{1s}^{*} orbital because

(1) σ_{2s} –orbital is bigger than σ_{1s} –orbital

(2) σ_{2s} is a bonding orbital whereas σ_{1s}^{*} is an antibonding orbital

(3) σ_{2s} –orbital has a greater value of *n* than σ_{1s}^{*} –orbital

(4) σ_{2s} –orbital is formed only after σ_{1s}

Energy of an orbitals $\propto$ n

72. The sequence of energy levels of MO's formed from the outermost shells of C_2 molecule is

(1) $\sigma(2s) < \sigma^{*}(2s) < \pi(2p_x) = \pi(2p_y) < \sigma(2p_z) < \pi^{*}(2p_x) = \pi^{*}(2p_y) < \sigma^{*}(2p_z)$

(2) $\sigma(2s) < \sigma^{*}(2s) < \pi(2p_x) = \pi(2p_y) < \sigma(2p_z) < \sigma^{*}(2p_z) < \pi^{*}(2p_y) = \pi^{*}(2p_z)$

(3) $\sigma(2s) < \sigma^{*}(2s) < \pi(2p_z) = \pi(2p_y) < \pi^{*}(2p_x) = \pi^{*}(2p_y) < \sigma^{*}(2p_y) < \sigma^{*}(2p_z)$

(4) $\sigma(2s) < \sigma^{*}(2s) < \sigma(2p_z) < \pi(2p_x) = \pi(2p_y) < \sigma^{*}(2p_z) < \pi^{*}(2p_x) = \pi^{*}(2p_y)$

The total no. of electron in C_2 molecule is < 14.

73. How many bonds (bond order) does B_2 have?

(1) 0 (2) 1 (3) 2 (4) 3

In B_2 molecule $B.O = \frac{6-4}{2} = 1$

74. Which among the following molecules/ions is diamagnetic?

(1) Super oxide ion (2) Oxygen

(3) Carbon molecule (4) Unipositive ion of N_2 molecule

There are no unpaired electrons in C^2

75. Which of the following contains maximum number of electrons in the antibonding molecular orbitals?

(1) O_2 (2) O_2^{2-} (3) O_2^{-} (4) O_2^{+}

O_2^{2-} has 4 electron in the π^{*} molecular orbitals

76. Which of the following molecules have unpaired electrons in antibonding molecular orbitals?

(1) O_2 (2) N_2 (3) C_2 (4) B_2

O_2 is paramagnetic.

77. In which set of molecules are all the species paramagnetic?

(1) B_2, O_2, N_2 (2) B_2, O_2, NO (3) B_2, F_2, O_2 (4) B_2, O_2, Li_2

B_2, O_2 and NO have unpaired electrons

HYDROGEN BOND & COORDINATE BOND

78. Hydrogen bonding is absent in

(1) H_2O (2) NH_3 (3) C_2H_5OH (4) $C_2H_5OC_2H_5$

In order to form H-bonds the H atom has to be bonded to O, N or F

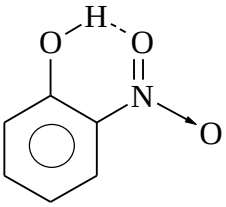
79. What is the maximum number of hydrogen bonds in which a water molecule can participate
(1) 1 (2) 2 (3) 3 (4) 4

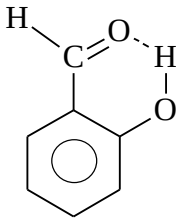
80. Which of the following hydrogen halides is most volatile?
(1) HF (2) HCl (3) HBr (4) HI
H – F has intermolecular H- Bonding.

81. Amongst H_2O, H_2S , H_2Se and H_2Te, the one with the highest boiling point is
(1) H_2O because of hydrogen bonding (2) H_2Te because of higher molecular weight
(3) H_2S because of hydrogen bonding (4) H_2Se because of lower molecular weight
Intermolecular H-bonding increases the boiling point

82. The boiling point is not affected due to hydrogen bonding in
(1) Water (2) ammonia (3) methyl alcohol (4) hydrogen chloride
No H-bonding present in HCl molecules

83. Intramolecular H–bonding is present in
(1) o–Nitrophenol (2) Salicylaldehyde (3) m–Nitrophenol (4) both (1) and (2)





84. Which of the following compounds has the least tendency to form hydrogen bonds between molecules?
(1) NH_3 (2) NH_2OH (3) HF (4) CH_3F
In order to form H-bonds the H atom has to be bonded to O, N or F

85. Incorrect order of decreasing boiling points is
(1) HF > HI >HBr>HCl (2) H_2O > H_2Te > H_2Se > H_2S
(3) Br_2> Cl_2> F_2 (4) CH_4> GeH_4> SiH_4
Boiling point increase with increase in molecular mass.

86. Which of the following has highest viscosity?
(1) Glycerol (2) Glycol (3) Ethanol (4) Water
Duet o extensive intermolecular H-bonding

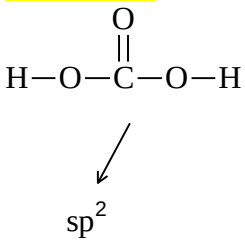
MISCELLANEOUS

33. If Z–axis is the molecular axis, then π–molecular orbitals are formed by the overlap of
(1) $s + p_z$ (2) $p_x + p_y$ (3) $p_z + p_z$ (4) $p_x + p_x$
π–bonds are perpendicular to σ–bonds

34. Which of the following combinations is not allowed (assumed Z–axis is internuclear axis)?
(1) 2*s* and 2*s* (2) $2p_x$ and $2p_x$ (3) 2*s* and $2p_z$ (4) $2p_x$ and $2p_y$
For effective overlap the orbitals should lie in a common plane.

36. Among the following compounds, the one that is polar and has the central atom with sp^2 hybridization is

(1) H_2CO_3 (2) SiF_4 (3) BF_3 (4) $HClO_2$



48. Which of the following statements is correct?

(1) A σ bond is weaker than a π bond

(2) There are four coordinate bonds in the NH_4^+ ion

(3) The covalent bond is directional in nature

(4) HF is less polar than HCl

Covalent bonds are associated with specific geometries

87. Which of the following does not contain any coordinate bond?

(1) H_3O^+ (2) BF_4^- (3) HF_2^- (4) NH_4^+

$\overline{HF_2}$ has H-bonding.

88. Which of the following are isoelectonic and isostructural?

NO_3^- , CO_3^{2-}, SO_3,ClO_3^-

(1) NO_3^-, CO_3^{2-} (2) SO_3 , NO_3^- (3) ClO_3^-, CO_3^{2-} (4) CO_3^{2-}, SO_3

Both N and C are sp^2 hybridation.

89. The correct order of O—O bond length in O_2, H_2O_2 and O_3 is

(1) $O_2 > O_3 > H_2O_2$ (2) $O_3 > H_2O_2 > O_2$ (3) $H_2O_2 > O_3 > O_2$ (4) $O_2 > H_2O_2 > O_3$

Bond length $\propto 1/\text{B.O}$

90. The correct order of increasing C – O bond length of CO, CO_3^{2-}, CO_2 is

(1) $CO_3^{2-} < CO_2 < CO$ (2) $CO_2 < CO_3^{2-} < CO$ (3) $CO < CO_3^{2-} < CO_2$ (4) $CO < CO_2 < CO_3^{2-}$

$$\text{Bonding length} \propto \frac{1}{\text{Bond order}}$$

LEVEL – 2

IONIC BOND

1. Which one is the correct statement with reference to solubility of $MgSO_4$ in water :

(1) Hydration energy of $MgSO_4$ is higher in comparison to its lattice energy

(2) Ionic potential of Mg^{2+} is very low

(3) SO_4^{2-} ion mainly contributes towards hydration energy

(4) Size of Mg^{2+} and SO_4^{2-} are similar

Solubility increases with increase in hydration energy.

2. Condition for ionic bond formation is/are :

(a) Small cation, large anion

(b) Low IP of cation, high electron affinity

(c) Large cation, small anion and less charge

(d) Less lattice energy

Correct answer is:

(1) a, d (2) b, c and d (3) b and c (4) a, b

$$I.P \propto \frac{1}{\text{size of cation}}$$

$$E.A \propto \frac{1}{\text{size of antion}}$$

3. The force responsible for dissolution of ionic compound in water is –

(1) Dipole – dipole forces (2) Ion – dipole force

(3) Ion – ion force (4) Hydrogen bond

Ionic compounds dissolve in water due to high polarity of H_2O molecule

4. Born Haber cycle is mainly used to determine

(1) Lattice energy (2) Electron affinity (3) Ionisation energy (4) Electronegativity

5. Highest melting point would be of

(1) $AlCl_3$ (2) LiCl (3) NaCl (4) $BeCl_2$

$$M.P \propto \frac{1}{\text{covalent charater}}$$

6. As compared to covalent compounds electrovalent compounds generally possess

(1) High m.p. and high b.p. (2) Low m.p. and low b.p.

(3) Low m.p. and high b.p. (4) high m.p. and low b.p.

Due to higher forces of attraction.

7. The electronic configuration of metal M is $1s^2\ 2s^2\ 2p^6\ 3s^1$. The formula of its oxide will be:

(1) MO (2) M_2O (3) M_2O_3 (4) MO_2

The metal M has a valency of 1

8. Which of the following does not show electrical conduction ?

(1) diamond (2) graphite

(3) sodium chloride (fused) (4) potassium

There are no free electrons in the structure of diamond

9. The most covalent halide is :-

(1) AlF_3 (2) $AlCl_3$ (3) $AlBr_3$ (4) AlI_3

Covalent character increases with increase in size of the anion.

10. LiCl is soluble in organic solvent while NaCl is not because :-

(1) Lattice energy of NaCl is less than that of LiCl

(2) Ionisation potential of Li is more than that of Na

(3) Li^+ has more hydration energy that Na^+ ion

(4) LiCl is more covalent compound than that NaCl

Like dissolves like

12. Correct order of covalent character of alkaline earth metal chloride in

(1) $BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2$ (2) $BeCl_2 < CaCl_2 < SrCl_2 < MgCl_2$

(3) $BeCl_2 > MgCl_2 > CaCl_2 > SrCl_2$ (4) $SrCl_2 > BeCl_2 > CaCl_2 > MgCl_2$

Smaller the cation greater will be the polarization

13. Which of the compound is least soluble in water
(1) AgF (2) AgCl (3) AgBr (4) AgI
AgI has maximum covalent character

14. CCl_4 is more covalent than LiCl because :
(1) There is more polarization of Cl in CCl_4 (2) There is more polarization of Cl in LiCl
(3) CCl_4 has more weight (4) None of above
Carbon is more electronegative than Li

15. The correct order of decreasing polarizable ions is :
(1) Cl^-, Br^-, I^-, F^- (2) F^-, I^-, Br^-, Cl^- (3) F^-, Cl^-, Br^-, I^- (4) I^-, Br^-, Cl^-, F^-
Larger anion are readily polarized

16. Ionic conductances of hydrated M^+ ions are in the order –
(1) $Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) > Cs^+(aq)$
(2) $Li^+(aq) > Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$
(3) $Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) < Cs^+(aq)$
(4) $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$
Smaller cations are more heavily hydrated

22. Correct order of melting point is ?
(1) $SnCl_2 > SnCl_4$ (2) $SnCl_4 > SnCl_2$ (3) $SnCl_2 = SnCl_4$ (4) None of these
$SnCl_4$ is more covalent than $SnCl_2$ (fajan's rule)

23. Which of the following suffers a weight loss on heating :-
(1) Li_2CO_3 (2) Washing soda (3) Both (1) and (2) (4) None

$$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2 \uparrow$$

$$Na_2CO_3.10H_2O \xrightarrow{\Delta} Na_2CO_3 + 10H_2O \uparrow$$

24. On heating Na_2CO_3 gives :-
(1) $Na_2O + CO_2$ (2) $Na_2 + CO_3$ (3) $Na + CO_2$ (4) None
Na_2CO_3 is stable to heat

25. Correct order of melting point is :-
(1) $NaF < MgF_2 < AlF_3$ (2) $AlF_3 > NaF > MgF_2$
(3) $MgF_2 < NaF < AlF_3$ (4) None
Melting point of ionic solids is directly proportional to their lattice energies.

OCTET RULE

27. Which among the following shows the limitation of Lewis octet rule?
(1) CH_4 (2) NO (3) CO_2 (4) NH_4^+
In NO molecule there is an incomplete octet on N –atom.

28. Which of the following is an example of expanded octet?
(1) SF_6 (2) PF_5 (3) H_2SO_4 (4) All of these
S and P have an expanded octet in the given compounds

COVALENT BOND

29. The strength of bonds by 2s – 2s, 2p – 2p and 2p – 2s overlapping has the order :-
(1) s – s > p – p > s – p (2) s – s > p – s > p – p
(3) p – p > s – p > s – s (4) p – p > s – s > p – s
p-orbitals have directional character and hence overlap more efficiently.

30. In which of the excitation state of chlorine ClF_3 is formed :-
(1) In ground state (2) In third excitation state
(3) In first excitation state (4) In second excitation state
Chlorine will have 3 unpaired electron in its 1st excited state and hence can form 3 bonds.

31. A sigma bond is formed by the overlapping of :-
(1) s-s orbital alone
(2) s and p orbitals alone
(3) s-s, s-p or p-p orbitals along intermuclear axis
(4) p-p orbital along the sides
σ – bonds are formed along the internuclear axis.

32. Which overlapping is involved in HCl molecule :-
(1) s-s overlap (2) p-p overlap (3) s-d overlap (4) s-p overlap
HCl molecule involves s-p overlap of atomic orbitals.

33. Which is not characteristic of π – bond :-
(1) π – bond is formed when a sigma bond already formed
(2) π – bond are formed from hybrid orbitals
(3) π – bond may be formed by the overlapping of p-orbitals
(4) π – bond result from lateral overlap of atomic orbitals
Hybrid orbitals can form only sigma bonds.

34. π bond is formed :-
(1) By overlapping of hybridized orbitals
(2) Overlapping of s – s orbitals
(3) Head on overlapping of p – p orbitals
(4) By p – p lateral overlapping
Lateral overlapping of p orbitals gives rise to π – bonds .

35. p-p overlapping will be observed in the molecules of:
(1) Hydrogen (2) Hydrogen bromide (3) Hydrogen chloride (4) Chlorine
In Cl_2 molecule the Cl atoms use their outer most p-orbitals for bonding.

36. Which compound of xenon is not possible
(1) XeF_2 (2) XeF_4 (3) XeF_5 (4) XeF_6
The excited states of Xe atoms can result in the formation of 2, 4, 6 and 8 covalent bonds by Xe.

37. Higher is the bond order, greater is –
(1) Bond dissociation energy (2) Covalent character
(3) Bond length (4) Paramagnetism
B.D.E $\propto$ Bond order

38. Which condition is not favourable for the combination of atomic orbitals:-
(1) The combining atomic orbitals nearly have the same energy
(2) The combining atomic orbitals must have the same symmetry about the molecular axis
(3) The combining orbitals must overlap to the maximum extent
(4) The combining orbitals must overlap to the minimum extent
The combining orbitals should have maximum overlap of the orbitals

HYBRIDISATION

39. In the protonation of H_2O, change occurs in
(1) Hybridisation state of oxygen
(2) Shape of molecule
(3) Hybridisation and shape both
(4) None

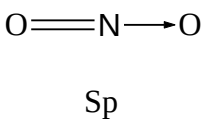
$$\underset{\text{V-shape}}{H_2O} \xrightarrow{H^+} \underset{\text{trigonal pyramidal shape}}{H_3O^+}$$

40. In the compound
$\overset{1}{C}H_2 = \overset{2}{C}H - \overset{3}{C}H_2 - \overset{4}{C}H_2 - \overset{5}{C} \equiv \overset{6}{C}H$, the $C^2 - C^3$ bond is formed by the overlapping of :-
(1) $sp - sp^2$ (2) $sp^3 - sp^3$ (3) $sp - sp^3$ (4) $sp^2 - sp^3$
No. of σ–bonds formed by C atoms is equalt o the number of hybrid orbitals used.

41. Which of the following elements can not exhibit sp^3d hybridization state:-
(a) C (b) P (c) Cl (d) B
Correct answer is :-
(1) a, c (2) a, d (3) b, c (4) b, d
C and B do not have a d-orbitals.

42. Which of the following species are expected to be planar :-
(a) NH_3 (b) $NH_2^{\oplus}$ (c) CH_3^+ (d) PCl_3
The correct answer is :-
(1) b and c (2) c and d (3) b and d (4) a and d
Both NH_2^+ and $\overset{+}{C}H_3$ have trigonal planar geometry.

43. In which following set of compound/ion has linear shaped
(1) CH_4, NH_4^+, BH_4^- (2) CO_3^{-2}, NO_3^-, BF_3 (3) NO_2^+, CO_2, XeF_2 (4) $BeCl_2, BCl_3, CH_4$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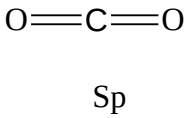
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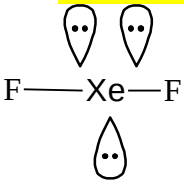
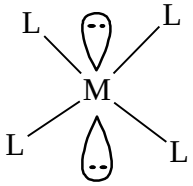

Sp^3d

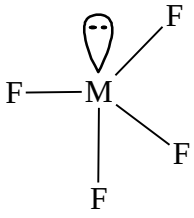
44. Which of the following set is not correct :-
(1) SO_3, O_3, NH_4^+ all have coordinate bonds
(2) H_2O, NO_2, ClO_2^-, all are V shape molecules
(3) I_3^-, ICl_2^-, NO_2^+; all are linear molecules
(4) SF_4, SiF_4, XeF_4 are tetrahedral in shape
SF_4: See-saw shape
SiF_4 : Tetrahedral
XeF_4: square planar

45. Shape of a molecule having 4 bond pairs and two lone pairs of electrons, will be :-
(1) Square planar (2) Tetra hedral (3) Linear (4) Octa hedral



Square planar shape.

46. The shape of IF_4^+ will be :-
(1) Square planar (2) Tetrahedral bipyramidal
(3) Pentagonal bipyramidal (4) Distorted tetrahedral



IF_4^+ has irregular tetrahedral shape.

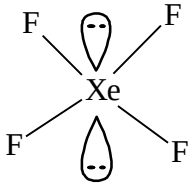
47. Which of the following has pyramidal shaped?
(1) BF_3 (2) H_3O^+ (3) NO_3^- (4) CO_3^{2-}
H_2O^+ is isostructural to NH_3

48. A σ bonded molecule MX_3 is T-shaped. The number of non-bonding pairs of electrons is
(1) 0
(2) 2
(3) 1
(4) Can be predicted if atomic number of M is known.
T-shaped geometry is obtained by sp^3d hybridization.

49. The type of hybrid orbitals used by chlorine atom in ClO^-, ClO_2^-, ClO_3^- and ClO_4^- is/are :-
(1) sp, sp^2, sp^3 and sp^3d (2) sp and sp^3
(3) Only sp^3 (4) only sp
The Cl atom shows sp^3 hybridisation in all the given ions.

50. On the basis of hybridization of one s and one p orbitals they are arrange at :-
(1) Two orbitals mutually at 90° angle (2) Two orbitals mutually at 180° angle
(3) Two orbitals mutually at 120° angle (4) Two orbitals mutually at 150° angle
Sp hybridization gives linear geometry

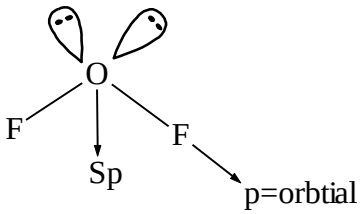
51. Which of the following having a square planar structure is
(1) NH_4^+ (2) BF_4^- (3) XeF_4 (4) CCl_4



square planar shape

52. When p-character of hybridized orbital (formed by s and p orbitals) increases. Then the bond angle
(1) Decreases (2) Increases (3) Becomes twice (4) Remains unaltered
Sp : 180^0
Sp^2:120^0
Sp^3: $109^028'$

53. Which orbitals overlap to form bond in OF_2
(1) $sp^3 - 2p$ (2) $sp^2 - 2p$ (3) $sp - 2p$ (4) $p - p$

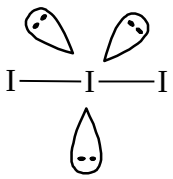


54. Among the following orbital/bonds, the angle is minimum between :
(1) sp^3 bonds (2) p_x and p_y orbitals
(3) H–O–H bond in water (4) sp bonds
P_x - P_y bond angle = 90^0

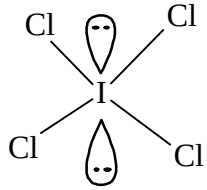
55. The AsF_5 molecule is trigonal bipyramidal. The hydrid orbitals used by the As atoms for bonding are :
(1) $d_{x^2-y^2}, d_{z^2}, p_x, p_y$ (2) d_{xy}, s, p_x, p_y, p_z (3) $s, p_x, p_y, p_z, d_{z^2}$ (4) $d_{x^2-y^2}, s, p_x, p_y$
In tbp geometry the orbitals used are S, Px, Py, Pz, dx^2

56. When the hybridization state of carbon atom changes from sp^3, sp^2 and sp, the angle between the hybridized orbitals.
(1) decrease considerably (2) increase progressively
(3) decrease gradually (4) all of these
Sp^3: $109^028'$
Sp^2: 120^0
Sp : 180^0

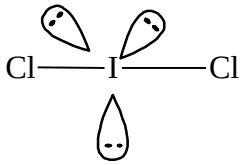
57. The hybridization states of the central atoms of the ions I_3^-, ICl_4^- and ICl_2^- are respectively :
(1) sp^2, sp^3d, sp^3 (2) sp^3d, sp^3d^2 and sp^3d (3) sp^3d, sp^3d, sp (4) sp, sp, sp^2



sp^3d

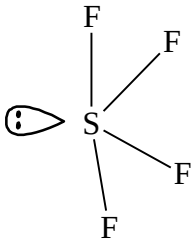


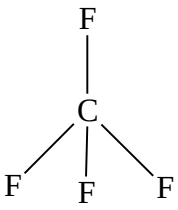
sp^3d^2

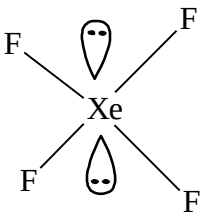


sp^3d

58. Molecular shapes of SF_4, CF_4 and XeF_4 are :-
(1) The same, with 2, 0 and 1 lone pairs of electrons respectively
(2) The same, with 1, 1 and 1 lone pairs of electrons respectively
(3) Different, with 0, 1 and 2 lone pairs of electrons respectively
(4) Different, with 1, 0 and 2 lone pairs of electrons respectively







59. Which of the following two are isostructural :-

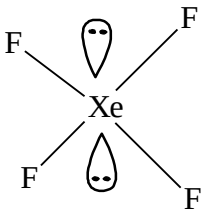
(1) XeF_2, IF_2^- (2) NH_3, BF_3 (3) CO_3^{2-}, SO_3^{2-} (4) PCl_5, ICl_5

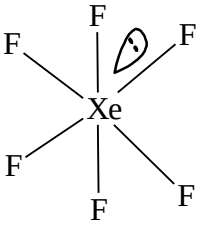
Isostructural are also isoelectronic

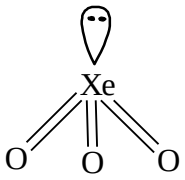
60. Select the correct matching :

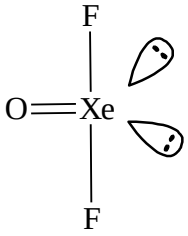
	List I		List II
A.	XeF_4	1.	Pyramidal
B.	XeF_6	2.	T-shape
C.	XeO_3	3.	Distorted octahedral
D.	$XeOF_2$	4.	Square planar

	A	B	C	D
(1)	4	3	1	2
(2)	1	2	3	4
(3)	2	1	3	4
(4)	4	1	3	2









61. Which one of the following pair is a correct with respect to molecular formula of xenon compound and hybridization state of xenon in it :

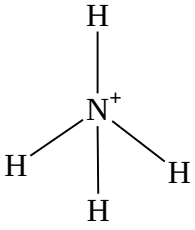
(1) XeF_4, sp^3 (2) XeF_2, sp (3) XeF_2, sp^3d (4) XeF_4, sp^2

$XeF_4 : sp^3d^2$

$XeF_2 : sp^3d$

62. The molecule does not have bent shape :-

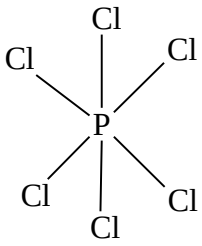
(1) SO_2 (2) O_3 (3) H_2O (4) NH_4^+



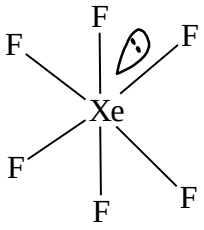
tetrahedral shape

63. Which among the given choice does not have the same hybridization and geometry of $(PCl_6)^-$?

(1) $(SiF_6)^{2-}$ (2) XeF_6 (3) SF_6 (4) $[Al(H_2O)_6]^{3+}$



Sp^3d^2 octahedral shape



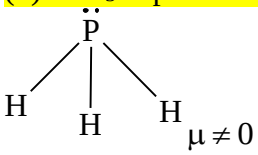
Sp^3d^3 distorted octahedral

64. Incorrect regarding the hybridization is :-
(1) The number of hybrid orbitals are equal to the number of the atomic orbitals that get hybridized
(2) The hybrid orbital are always equivalent in energy and shape
(3) The hybrid orbitals are more effective in forming stable bonds than the pure atomic orbitals
(4) Overlapping and hybridization are same phenomenon
Hybridisation process involves the mixing of orbitals of the same atom.

65. The percent s-character in CH_4 is :-
(1) 100% (2) 45% (3) 75% (4) 25%
CH_4 sp^3 dybridisation

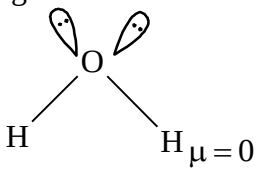
DIPOLE MOMENT

66. Which statement is correct :-
(1) All the compounds having polar bonds, have dipole moment
(2) SO_2 is non-polar
(3) H_2O molecule is non polar, having polar bonds
(4) PH_3 is polar molecule having non polar bonds



$\mu \neq 0$

67. BeF_2 has zero dipole moment where as H_2O has a dipole moment because :-
(1) Water is linear (2) H_2O is bent
(3) F is more electronegative that O (4) Hydrogen bonding is present in H_2O

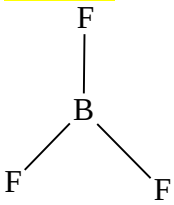


$\mu = 0$

$F - Be - F$

$\mu = 0$

68. Which of the following molecule have zero dipole moment :-
(1) BF_3 (2) CH_2Cl_2 (3) NF_3 (4) SO_2

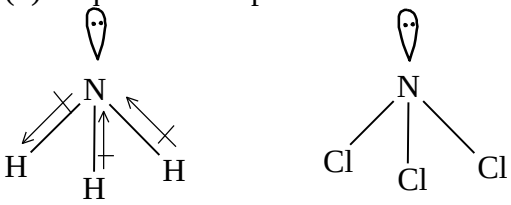


Sp^2 symmetrical molecule

69. The dipole moment of NH_3 is :-

(1) Less than dipole moment of NCl_3 (2) Higher than dipole moment of NCl_3

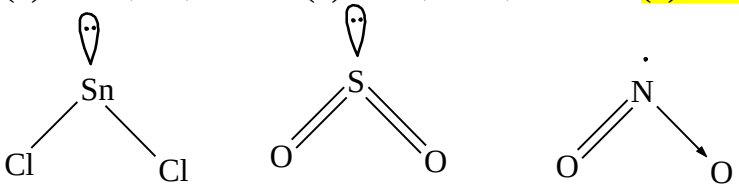
(2) Equal to the dipole moment of NCl_3 (4) None of these



In NCl_3 the difference in electronegativity is less.

70. Which set of molecules is polar :-

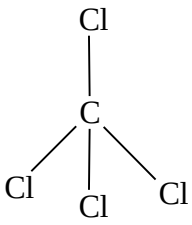
(1) XeF_4, IF_7, SO_3 (2) PCl_5, C_6H_6, SF_6 (3) $SnCl_2$, SO_2, NO_2 (4) CO_2, CS_2, C_2H_6



$\mu \neq 0$ $\mu \neq 0$ $\mu \neq 0$

71. Which of the following has symmetrical structure :

(1) PCl_3 (2) CH_2Cl_2 (3) $CHCl_3$ (4) CCl_4

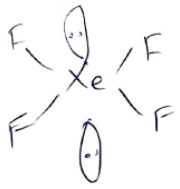


sp^3 hybridisation Tetrahedral geometry.

72. Species having zero dipole moment :-

(1) XeF_4 (2) 1,2,4 trichloro benzene

(3) SF_4 (4) CH_2Cl_2

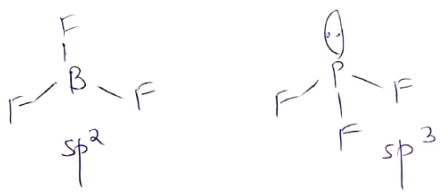


square planar shape

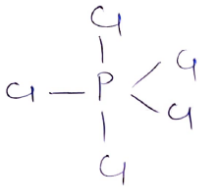
73. What conclusion can be drawn from the fact that BF_3 has no dipole moment but PF_3 does

(1) BF_3 is not symmetrical but PF_3 is (2) BF_3 molecule must be linear

(3) Atomic radius of P is larger than that of B (4) BF_3 molecule must be planar triangular



74. PCl_5 is non polar because :-
(1) P – Cl bond is non-polar
(2) Its dipole moment is zero
(3) P – Cl bond is polar
(4) P and Cl have equal electronegativity



tbp geometry (symmetrical molecule)

75. Dipole moment of CO_2 is zero which implies that:
(1) Carbon and oxygen have equal electronegativities
(2) Carbon has no polar bond
(3) CO_2 is a linear molecule
(4) Carbon has bond moments of zero value

$O = C = O$ linear geometry

76. The correct order of dipole moment is :
(1) $CH_4 < NF_3 < NH_3 < H_2O$
(2) $NF_3 < CH_4 < NH_3 < H_2O$
(3) $NH_3 < NF_3 < CH_4 < H_2O$
(4) $H_2O < NH_3 < NF_3 < CH_4$

Dipole moment of CH_4=0
H_2O has the highest dipole moment due to max. electronegativity difference and minimum bond angle.

77. Which of the following has the highest value of dipole moment :
(1) HCl (2) HF (3) HI (4) HBr

78. Which compounds has permanent dipole moment :
(A) BF_3 (B) SiF_4 (C) SF_4 (D) XeF_4
(E) XeF_2 (F) $CHCl_3$
(1) A & B (2) C & D (3) D, E & F (4) C & F

79. Which molecule has largest dipole moment :
(1) CH_4 (2) $CHCl_3$ (3) CCl_4 (4) CHI_3
CH_4 and CCl_4 $\mu = 0$
$CHCl_3 > CHI_3$
Due to higher difference in electronegativity.

80. Which of the following is the most polar :-
(1) CCl_4 (2) $CHCl_3$ (3) CH_2Cl_2 (4) CH_3Cl

81. The molecule does not have zero dipole moment :-
(1) CO_2 (2) CCl_4 (3) BF_3 (4) HCl

82. Which of the following compound possess dipole moment :-
(1) Water (2) Boron trifluoride (3) Benzene (4) Carbon tetra chloride

MOLECULAR ORBITAL THEORY

83. The ion that is isoelectronic with CO and having same bond order is :-
(1) CN^- (2) O_2^+ (3) O_2^- (4) N_2^+

Both CO and CN^- have the same bond order as they are isoelectronic

84. Which of the following is paramagnetic :-
(1) O_2^- (2) CN^- (3) CO (4) NO^+
O_2^- has one unpaired electron in its π^* orbital

85. In the following which of the two are paramagnetic
(a) N_2 (b) CO (c) B_2 (d) NO_2
Correct answer is :
(1) a and c (2) b and c (3) c and d (4) b and d
B_2 and NO_2 are paramagnetic due to presence of unpaired electrons in their molecular orbitals

86. The bond order of CO molecular on the basis of molecular orbital theory is
(1) Zero (2) 2 (3) 3 (4) 1
B.O of CO = 3
$N_b = 10$ $N_a = 4$
B.O = $\frac{10-4}{2} = 3$

87. Which of the following species will have the minimum bond energy
(1) N_2 (2) N_2^- (3) N_2^+ (4) N_2^{-2}
Higher the B.O. higher is the bond energy.

88. Which of the following ion do not have bond order of 2.5 ?
(1) O_2^- (2) O_2^+ (3) N_2^+ (4) N_2^-
O_2^- has a bond order of 1.5

89. The electron adds to which one of the following orbitals during change of N_2 to N_2^-.
(1) σ orbital (2) σ^* orbital (3) π^* orbital (4) π orbital
The electron adds to a $\pi*$ molecular orbital

90. In which of the following species removal of electron exhibit a decrease in paramagnetic behavior?
(1) F_2 (2) N_2 (3) C_2 (4) B_2
B_2 molecule has 2 unpaired electrons .

91. Pick the wrong statement w.r.t. molecular orbital theory (MOT).
(1) Participation of orbital of comparable energies takes place.
(2) The electron is under the influence of two or more than two nuclei.
(3) The molecular orbital formed is equal to the number of atomic orbitals combined
(4) The probability of electron distribution in a molecule is given by atomic orbitals only.
Molecular orbtials are formed by the LCAO method.

92. Which among the following species is does not exist ?
(1) He_2^+ (2) H_2^+ (3) H_2^- (4) Be_2
Bond order in Be_2 = O

93.

94. The given species not having the same bond order as of other three :-
(1) He_2^+ (2) H_2^+ (3) H_2^- (4) Li_2
He_2^+, H_2^+ and H_2^- has a B.O = 0.5

95. The minimum bond length will be observed in :-
(1) O_2 (2) O_2^- (3) O_2^+ (4) O_2^{2-}

Bond length $\propto \frac{1}{\text{Bond order}}$

96. Which among the given pair of molecules consists only of $\text{Pi}(\pi)$ bonds?
(1) B_2 and F_2 (2) B_2 and C_2^{2+} (3) N_2 and O_2 (4) C_2 and N_2

Both $B_2 + C_2^{2+}$ consists of pi bonds only.

99. Which molecule does not exist :
(1) He_2 (2) O_2 (3) N_2 (4) B_2

Bond order of He_2 = O

100. Which is correct electronic configuration for C_2 molecule according to M.O.T.
(1) $KK(\sigma 2S)^2(\sigma^* 2s)^2(\pi 2Px^2 = \pi 2Py^2)$ (2) $KK(\sigma 2s^2)(\sigma^* 2s)^2(\pi 2Px^1 = \pi 2Py^1)\sigma 2Pz^2$
(3) $KK(\sigma^* 2s^2)(\sigma 2s)^2(\pi 2Px^2 = \pi 2Py^2)$ (4) $KK(\sigma 2s^2)(\sigma^* 2s^2)^2 \sigma 2Pz^2(\pi 2Px^1 = \pi 2Py^1)$

C_2 molecule consists of 12 electrons

101. The molecule/species having highest bond order :-
(1) O_2 (2) O_2^- (3) O_2^+ (4) O_2^{-2}

B.O $\propto$ no. of electrons in BMO's

102. The calculated bond order in H_2^- ion is :-
(1) 0 (2) $\frac{1}{2}$ (3) $-\frac{1}{2}$ (4) 1

H_2^- B.O = 0.5

103. O_2 molecule is paramagnetic due to :-
(1) It contains 2 unpaired electrons in $\pi^* 2Px$ and $\pi^* 2Py$ molecular orbitals
(2) It contains no unpaired electrons in $\pi^* 2Px$ and $\pi^* 2Py$ molecular orbitals
(3) It contains 2 paired electrons in $\sigma 2s$ orbital
(4) It contains 1 unpaired electrons in $\sigma 2s$ orbital

There are 2 unpaired electrosn in the π^* Molecular orbitals in O_2

104. Which is not correct according to M.O.T.
(1) Nb > Na Positive bond order
(2) Nb < Na Negative bond order
(3) Nb = Na Zero bond order
(4) Nb > Na Negative bond order

When $N_b > N_a$ then B.O. will be +ve

105. The molecule having bond order 3 is :-
(1) H_2 (2) N_2 (3) O_2 (4) He_2^+

N_2 has a bond order of 3

106. Which is correct electronic configuration for singly positive nitrogen molecule :-
(1) $\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2\ \pi 2p_y^2\ \sigma 2p_z^1$

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

(3) $\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^1$

(4) $\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_z^1$

N_2^+ is a 13 electron system

107. Two nodal planes are present in :-
(1) $\pi^* 2p_x$ (2) $\sigma 2p_z$ (3) $\pi 2p_x$ (4) $\pi 2p_y$

108. Which is the most stable :-
(1) N_2 (2) N_2^+ (3) N_2^- (4) N_2^{-2}
B.O $\propto$ statbility

109. Which set of molecules having same sequence of energy levels.
(1) B_2, O_2, N_2 (2) O_2, Be_2, F_2 (3) B_2, C_2, N_2 (4) N_2, O_2, B_2
B_2, C_2, N_2 have 14 or <14 electrons

COORDINATE BOND

110. In Co-ordinate bond, the acceptor atoms must essentially contain in its valency shell an orbital:-
(1) With paired electron (2) With single electron
(3) With no electron (4) With three electron
The acceptor atom should accept the electron pair to form a coordinate bond

111. The bonds present in N_2O_5 are :-
(1) Only ionic (2) Covalent and coordinate
(3) Only covalent (4) Covalent and ionic

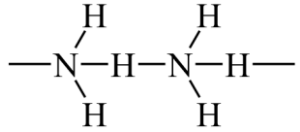
112. Dative bond is present in
(1) SO_3 (2) NH_3 (3) K_2CO_3 (4) BF_3

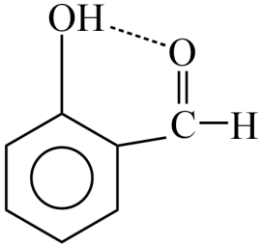
113. The compound containing co-ordinate bond is :
(1) H_2SO_4 (2) O_3 (3) SO_3 (4) All of these

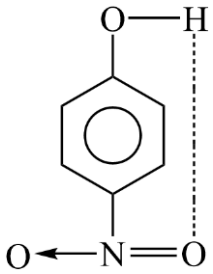
WEAK FORCES

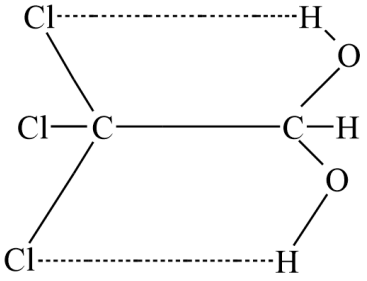
114. Intermolecular hydrogen bonds are not present in :-
(1) CH_3CH_2OH (2) CH_3COOH (3) $C_2H_5NH_2$ (4) CH_3OCH_3
In order to from H-bonds the H-atom should be directly bonded to O, N, or F

115. In which of the following molecule, the shown hydrogen bond is not possible :

(1) 

(2) 

(3) 

(4) 

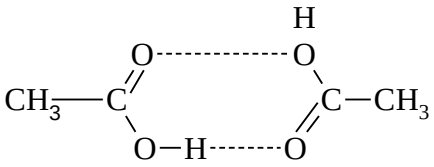
p-nitrophenol forms intermolecular H-bonds

116. Correct order of volatility is :-
(1) HF > HCl > HBr > HI
(2) HCl > HBr > HI > HF
(3) HI > HBr > HCl > HF
(4) HBr < HCl < HI < HF
HF has intermolecular H-bonds

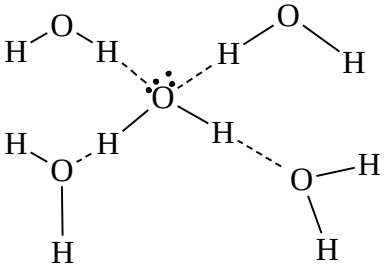
117. The correct order of volatility is :-
(1) $NH_3 < H_2O$
(2) p-nitro phenol < o-nitro phenol
(3) $CH_3OH > CH_3 – O – CH_3$
(4) HF > HCl
p-nitrophenol forms intermolecular H-bonds

118. The incorrect order of decreasing boiling points is
(1) $NH_3 > AsH_3 > PH_3$
(2) $H_2O > H_2Se > H_2S$
(3) $Br_2 > Cl_2 > F_2$
(4) $CH_4 > GeH_4 > SiH_4$
Boiling point α molecular mass

119. Acetic acid exists as dimer in benzene due to :-
(1) Condensation reaction
(2) Hydrogen bonding
(3) Presence of carboxyl group
(4) None of the above



120. Maximum no. of hydrogen bonds formed by a water molecule in ice is
(1) 4 (2) 3 (3) 2 (4) 1



121. Strongest hydrogen bond is shown by :
(1) Water (2) Ammonia (3) Hydrogen fluoride (4) Hydrogen sulphide
H-F forms the strongest H-bond

122. Density of ice is less than that of water because of
(1) presence hydrogen bonding
(2) crystal modification of ice
(3) open porous structure of ice due to hydrogen bonding

(4) different physical states of these
The porous structure in ice decreases the density.

123. NH_3 has abnormally high boiling point because it has :
(1) Alkaline nature (2) Distorted shape (3) sp^3 – Hybridisation (4) Hydrogen bonding
H-bonding in NH_3 increases its boiling point?

124. Which of the following is soluble in water ?
(1) CS_2 (2) C_2H_5OH (3) CCl_4 (4) $CHCl_3$
Due to H-bonding

125. KF combines with HF to form KHF_2. The compound contains the species :
(1) K^+, F^- and H^+ (2) K^+, F^- and HF (3) K^+ and $[HF_2]^-$ (4) $[KHF]^+$ and F_2
$K^+F^-.....H-F$

ASSERTION & REASON

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. **Assertion :** Water is a good solvent for ionic compounds but poor one for covalent compounds.
Reason : Hydration energy of ions releases sufficient energy to overcome lattice energy and break hydrogen bonds in water, while covalent bonded compounds interact so weakly that even Vander Waal's forces between molecules of covalent compounds cannot be broken.
(a)

2. **Assertion :** The atoms in a covalent molecule are said to share electrons, yet some covalent molecules are polar.
Reason : In a polar covalent molecule, the shared electrons spend more time on the average near one of the atoms?
(a)

3. **Assertion :** Diborane is electron deficient
Reason : There are no enough valence electrons to form the expected number of covalent bonds
(a)

4. **Assertion :** A resonance hybrid is always more stable than any of its canonical structures
Reason : This stability is due to delocalization of electrons
(a)

5. **Assertion :** All F – S – F angle in SF_4 greater than 90° but less than 180°
Reason : The lone pair-bond pair repulsion is weaker than bond pair-bond pair repulsion.
(c)

6. **Assertion :** Bond order can assume any value number including zero
Reason : Higher the bond order, shorter is bond length and greater is bond energy
(b)

7. **Assertion :** Ortho nitrophenol molecules are associated due to the presence of intermolecular hydrogen bonding while paranitrophenol involves intramolecular, hydrogen bonding
Reason : Ortho nitrophenol is more volatile than the paranitrophenol

(e)

8. **Assertion :** Nitrogen molecule is diamagnetic.
Reason : N_2 molecule have unpaired electrons.
(c)

9. **Assertion :** Ice is less dense than liquid water.
Reason : There are vacant spaces between hydrogen bonded water molecules in ice.
(a)

10. **Assertion :** Water is liquid but H_2S is a gas.
Reason : Oxygen is paramagnetic.
(b)

11. **Assertion :** Iodine is more soluble in water then in carbon tetrachloride.
Reason : Iodine is a polar compound.
(d)

12. **Assertion :** o and p-nitrophenols can be separated by steam distillation.
Reason : o-nitrophenol have intramolecular hydrogen bonding while p-nitrophenol exists as associated molecules.
(a)

13. **Assertion :** Fluorine has lower reactivity.
Reason : F – F bond has low bond dissociation energy.
(e)

14. **Assertion :** σ is strong while π is a weak bond.
Reason : Atoms rotate freely about π bond.
(c)

15. **Assertion :** The crystal structure gets stabilized even though the sum of electron gain enthalpy and ionization enthalpy is positive.
Reason : Energy is absorbed during the formation of crystal lattice.
(c)

16. **Assertion :** Order of lattice energy for same halides are as LiX > NaX > KX
Reason : Size of alkali metal increases from Li to K.
(a)

17. **Assertion :** Born-Haber cycle is based on Hess's law.
Reason : Lattice enthalpy can be calculated by Born- Haber cycle.
(b)

18. **Assertion :** Bond energy has order like $C-C<C=C<C\equiv C$.
Reason : Bond energy increases with increase in bond order.
(a)

19. **Assertion :** Electron affinity refers to an isolated atom's attraction for an additional electron while electronegativity is the ability of an element to attract electrons towards itself in a shared pair of electrons.
Reason : Electron affinity is a relative number and electronegativity is experimentally measurable.
(c)

20. **Assertion :** Geometry of SF_4 molecule can be termed as distorted tetrahedron, a folded square or see saw.
Reason : Four fluorine atoms surround or form bond with sulphur molecule.
(b)

21. **Assertion :** BF_3 has greater dipole moment than H_2S.
Reason : Fluorine is more electronegative than sulphur.
(e)

22. **Assertion :** The bond between two identical nonmetal atoms has a pair of electrons with identical spin.
Reason : Electrons are transferred fully from one atom to another.
(d)

23. **Assertion :** B_2 molecule is diamagnetic.
Reason : The highest occupied molecular orbital is of σ type.
(d)

24. **Assertion :** The nearly tetrahedral arrangement of the orbitals about the oxygen atom allows each ice molecule to form hydrogen bonds with as many as four neighbouring water molecules.
Reason : In ice each molecule forms four hydrogen bonds as each molecule is fixed in the space.
(a)

25. **Assertion :** The bond order of helium is always zero.
Reason : The number of electrons in bonding molecular orbital and antibonding molecular orbital is equal.
(a)

PREVIOUS YEARS QUESTIONS

1. Among the following group which represents the collection of isoelectronic species? **[CBSE AIMPT 2000]**

(a) NO, CN^-, N_2, O_2^- (b) $NO^+, C_2^{2-}, O_2^-, CO$

(c) N_2, C_2^{2-}, CO, NO (d) CO, NO^+, CN^-, C_2^{2-}

Species having equal number of electrons are known as isoelectronic species.
Number of electrons,
In CO = 6+8 =14
In NO^+ = 7 +8 – 1 = 14
In CN^-=6+7+7 = 14
In C_2^{2-} = 12+2=14
Hence, all have 14 electrons, so they are isoelectronic species

2. Which one of the following is not paramagnetic? **[CBSE AIPMT 2000]**

(a) NO (b) N_2^+ (c) CO (d) O_2^-

Paramagnetic character is shown by those atoms or molecules which have unpaired electrons.
In the given compounds CO is not paramagnetic since, it does not have unpaired electrons. The configuration of CO molecule is

$$CO(14) = \sigma 1s^2, \dot{\sigma} 1s^2, \sigma 2s^2, \dot{\sigma} 2s^2, \sigma 2p_x^2, \pi 2p_y^2 = \pi 2p_z^2$$

3. The relationship between the dissociation energy of N_2 and N_2^+ is **[CBSE AIPMT 2000]**

(a) dissociation energy of N_2^+ > dissociation energy of N_2

(b) dissociation energy of N_2 = dissociation energy of N_2^+

(c) dissociation energy of N_2> dissociation energy of N_2^+

(d) dissociation energy of N_2 can either be lower or higher than the dissociation energy of N_2^+

The dissociation energy will be more when the bond order will be greater and bond order ∝ dissociation energy Molecular orbital configuration of

$N_2(14) = \sigma 1s^2, \overset{\bullet}{\sigma} 1s^2, \sigma 1s^2, \overset{\bullet}{\sigma} 2s^2, \pi 2p_y^2 = \pi 2p_z^2, \sigma 2p_x^2$

So bond order of

$$N_2 = \frac{N_b - N_a}{2} = \frac{10-4}{2} = 3$$

And bond order of $N_2^+ = \frac{9-4}{2} = 2.5$

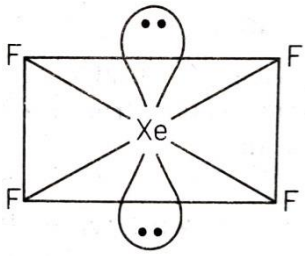
As the bond order of N_2 is greater than N_2^+ so, the dissociation energy of N_2 will be greater than N_2^+.

4.

5. Which one of the following is planar? **[CBSE AIMPT 2000]**

(a) XeF_4 (b) XeO_4 (c) XeO_3F (d) XeO_3F_2

Structure of XeF_4 is as follows



It involves sp^3d^2 hybridisation in Xe-atom. The molecules has square planar structure. Xe and four F –atoms are coplanar. The lone pair are present on axial positions, minimize electron pair repulsion.

6. A compound contains atoms A, B and C. If the oxidation number of A is +2, B is +5 and that of C is -2, the possible formula of the compound is **[CBSE AIMPT 2000]**

(a) $A_2(BC_3)_2$ (b) $A_3(BC_4)_2$ (c) $A_3(B_4C)_2$ (d) ABC_2

In $A_3(BC_4)_2$ 3x oxidation number of A + 2 [oxidation number of $B + 4\times$ oxidation number of C] =0

$3\times(+2) + 2[5 + 4\times(-2)] = 0$

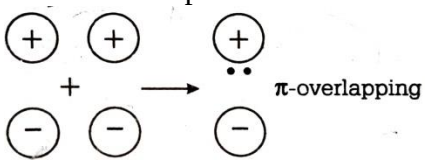
$6 + 2[-3] = 0$

7. Main axis of a diatomic molecule is z, molecular orbital p_x and p_y overlaps to form which of the following orbitals. **[CBSE AIMPT 2001]**

(a) π – molecular orbital (b) σ – molecular orbital

(c) δ – molecular orbital (d) No bond will form

For π – overlap the lobes of the atomic orbitals are perpendicular to the line joining the nuclei



8. In X – H ---Y, X and Y both are electronegative elements, then **[CBSE AIMPT 2001]**

(a) electron density on X will increases and on H will be decrease

(b) In both electron density will increase

(c) in both electron density will decrease

(d) On X electron density will decrease and on H increase

In X – H –Y, X and Y both are electronegative elements, then electron density on X will increase and on H will decrease.

9. Which of the following two are isostructural? **[CBSE AIPMT 2001]**

(a) XeF_2 and IF_2^- (b) NH_3 amd BF_3

(c) CO_3^{2-} and SO_3^{2-} (d) PCl_5 and ICl_5

Compounds having same structure and same hybridization are known as isostructural species e.g. XeF_2 and IF_2^- are sp^3d hybridized and same hybridization and both have linear shape.

$F-I^- -F$ $F-Xe-F$

10. In which of the following, bond angle is maximum? **[CBSE AIPMT 2001]**

(a) NH_3 (b) NH_4^+ (c) PCl_3 (d) SCl_2

In NH_4^+ bond angle is maximum (nearer 109^0) due to its tetrahedral geometry.

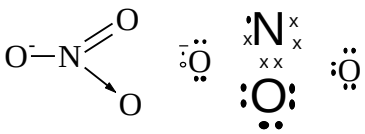
11. Which of the following has $p\pi - d\pi$ bonding **[CBSE 2002]**

(a) NO_3^- (b) CO_3^{-2} (c) BO_3^{-3} (d) SO_3^{-2}

12. In NO_3^- ion number of bond pair and lone pair of electrons on nitrogen atom are **[CBSE AIPMT 2002]**

(a) 2, 2 (b) 3, 1 (C) 1, 3 (d) 4, 0

In NO_3^- ion

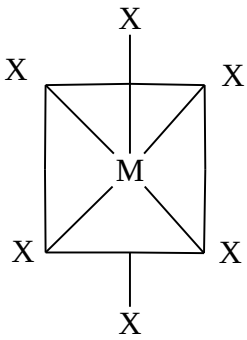


Nitrogen has four bond pair and zero lone pair of electrons, due to the presence of one coordination bond.

13. In a regular octahedral molecule, MX_6, the number $X-M-X$ bonds at 180° is **[CBSE PMT 2004]**

(a) Six (b) Four (c) Three (d) Two

In octahedral structure MX_6, the six hubrid orbitals (sp^3d^2) are directed towards the corners of a regular octahedral with an angle of 90^0. According to following structure of MX_6, the number of X – M–X bonds at 180^0 must be three.



14. In an octahedral structure, the pair of d orbitals involved in sp^3d^2 hybridization is **[CBSE PMT 2004]**

(a) d_{x^2}, d_{xz} (b) d_{xy}, d_{yz} (c) $d_{x^2-y^2}, d_{z^2}$ (d) $d_{xz}, d_{x^2-y^2}$

In the formation of d^2sp^3 hybrid orbitals, two (n – 1) d-orbitals of e_g set i.e., (n -1)d_{z^2} and (n – 1) $d_{x^2-y^2}$ orbitals, one n s and three np(np_x, np_y and np_z) orbitals combine together.

15. Among the following the pair in which the two species are not isostructural is **[CBSE PMT 2004]**

(a) BH_4^- and NH_4^+ (b) PF_6^- and SF_6 (c) SiF_4 and SF_4 (d) IO_3^- and XeO_3

16. H_2O is dipolar, when BeF_2 is not =. It is because **[CBSE AIPMT 2004]**

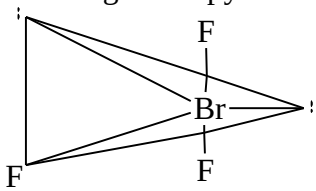
(a) the electronegativity of F is greater than that of O
(b) H_2O involves hydrogen bonding whereas BeF_2 is a discrete molecule
(c) H_2O is linear and BeF_2 is angular
(d) H_2O is angular and BeF_2 is linear

The structure of H_2O is angular or V-shape and has sp^3-hybridisation and 104.5^0 bond angle. Thus, its dipole mo ment is positive or more than zero.
But in BeF_2, structure is linear due to sp hybridization ($\mu = 0$)
Thus, due to $\mu > 0, H_2O$ is dipolar and due to $\mu = 0, BeF_2$ is non-polar.

17. In BF_3 molecule, the lone pairs occupy equatorial position to minimize. **[CBSE AIPMT 2004]**

(a) lone pair-bond pair repulsion
(b) bond pair-bond pair repulsion
(c) lone pair-lone pair repulsion and lone pair-bond pair repulsion
(d) lone pair-lone pair repulsion.

In BrF_3 molecule, Br is sp^3d hybridized, but its geometry is T-shaped due to distortion of geometry from trigonal bipyramidal to T-shaped by the involvement of lone pair-plone repulsion



Here lp – lp respulsion = 0
lp – bp repulsion = 4
bp – bp repulsion = 2

18. Which of the following would have a permanent dipole moment? **[CBSE AIPMT 2005]**

(a) BF_3 (b) SiF_4 (c) SF_4 (d) XeF_4

19. The electronegativity difference between N and F is greater than that between N and H yet the dipole moment of NH_3 (1.5 D) is larger than that of NF_3 (0.2 D). This is because: **[CBSE Med 2006]**

(a) in NH_3 the atomic dipole and bond dipole are in the same direction whereas in NF_3, the same opposite directions.
(b) in NH_3 as well as NF_3 the atomic dipole and bond dipole are in opposite direction.
(c) in NH_3 the atomic dipole and bond dipole are in the opposite directions whereas in NF_3 these are in the same direction
(d) in NH_3 as well as in NF_3 the atomic dipole and bond dipole are in the same direction.

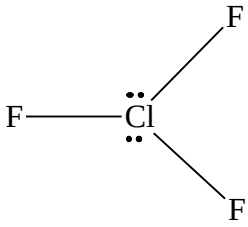
F is more electronegative than N, therefore direction of bond is form N to F whereas N is more electronegative than H, the direction of the bond is from H to N. Yhus whereas resultant moment of

N – H bonds adds up to the bond moment of lone pair, that of 3N – F bonds partly cancel the resultant moment of lone pair. Hence, the net dipole moment of NF_3 is less than that of NH_3.

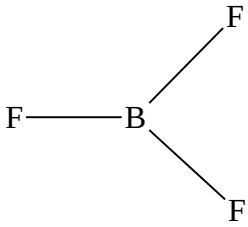
20. In which of the following molecules are all the bonds not equal? **[CBSE AIPMT 2006]**

(a) ClF_3 (b) BF_3 (c) AlF_3 (d) NF_3

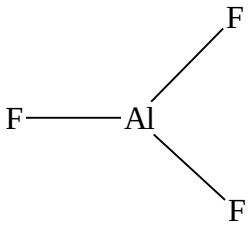
In ClF_3 all bonds are not equal due to its trigonal-bipyramidal (sp^3d hybridization) geometry



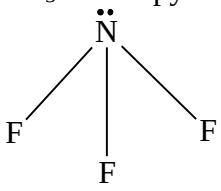
BF_3 and Alf_3 show trigonal symmetric structure due to sp^2 hybridisation.



And



NF_3 shows pyramidal geometry due to sp^3 hybridisation



3bp+1/p

21. Which of the following is not a correct statement. **[CBSE AIPMT 2006]**

(a) The electron deficient molecule can act as Lewis acids.

(b) The canonical structures have no real existence

(c) Every AB_5 molecule does infact have square pyramid structure

(d) Multiple bonds are always shorter than corresponding single bond.

Generally, AB_5 molecules have trigonal bipyramidal structure due to sp^3 hybidisation but in some cases due to presence of lone pair of electrons, its geometry becomes distorted.

22. Which of the following is not isostructural with $SiCl_4$? **[CBSE AIPMT 2006]**

(a) SCl_4 (b) SO_4^{2-} (C) PO_4^{3-} (D) NH_4^+

SCl_4 is not isostructural with $SICl_4$ because it shows square planar structure due to involvement of repulsion between lone pair and bond pair of electrons.

SO_4^{2-} shows tetrahedral structure due to sp^3 hybridisaton.

PO_4^{3-} shows tetrahedral structure due to sp^3hybridisaton.

NH_4^+ shows tetrahedral structure due to sp^3 hybridisation.

23. The number of unpaired electrons in a paramagnetic diatomic molecule of an element with atomic number 16 is **[CBSE AIMPT 2006]**

(a) 2 (b) 3 (c) 4 (d) 1

Suppose the diatomic molecule is X. Then, molecular orbital electronic configuration of

$$_{18}X = \sigma 1s^2, \dot{\sigma} 1s^2, \sigma 2s^2, \dot{\sigma} 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \dot{\pi} 2p_x^1 = \dot{\pi} 2p_y^1$$

Due to presence of two unpaired electrons, it shows paramagnetic character.

24. In which of the following pairs, the two species are isostructural? **[CBSE AIPMT 2007]**

(a) SF_4 and XeF_4 (b) SO_3^{2-} and NO_3^- (c) BF_3 and NF_3 (d) BrO_3^- and XeO_3

SF_4= irregular tetrahedral (sp^3d, one lone pair)

XeF_4 = square planar (sp^3d^2, two lone pairs)

(a) SO_3^{2-} =pyramidal (sp^3, one lone pair

NO_3^- = trigonal planar (sp^2)

(b) BF_3 = trigonal planar (sp^2)

NF_3 =pyramidal (sp^3)

(c) BrO_3^- =pyramidal (sp^3, one lone pair)

XeO_3= pyramidal (sp^3, one lone pair)

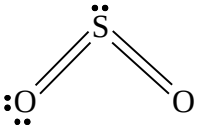
25. Which of the following species has a linear shape? **[CBSE AIPMT 2007]**

(a) NO_2^- (b) SO_2 (c) NO_2^+ (d) O_3

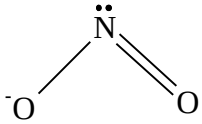
$\overset{+}{N}O_2$ has linear shape due to sp hybridization of N in $\overset{+}{N}O_2$

$O = \overset{+}{N} = O$

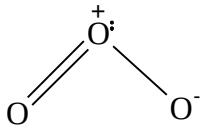
Which SO_2, NO_2^- and O_3 have angular shape



V-shape



V-shape



V-shape

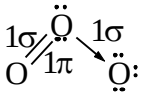
Angular shape (due to sp^2 hybridisation of central atom or ion)

26 The angular shape of ozone molecule (O_3) consists of **[CBSE AIPMT 2008]**

(a) 1 sigma and 2 pi-bonds (b) 2 sigma and 2 pi-bonds

(c) 1 sigma and 1 pi-bonds (d) 2 sigma and 1 pi-bonds

In case of single bond, there is only one σ and one π-bonds while in case of triple bond, there is one σ and two π-bonds.. Thus angular shape of ozone (O_3) contains 2σ and $1\pi-$bonds as shown below



2 sigma and one $\pi-$bonds.

27. What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas? **[CBSE PMT 2009]**

(a) Dipole-diople interactions (b) Covalent bonds

(c) London disperson force (d) Hydrogen bonding.

In between CH_3OH molecules intermolecular H-bonding exist.

Hence it is the intermolecular H-bonding that must be overcome in converting liquid CH_3OH to gas .

28. Four diatomic species are listed below. Identify the correct order in which the bond order is increasing in them: **[AIPMT 2009]**

(a) $C_2^{2-} < He_2^+ < O_2^- < NO$ (b) $He_2^+ < O_2^- < NO < C_2^{2-}$

(c) $NO < O_2^- < C_2^{2-} < He_2^+$ (d) $O_2^- < NO < C_2^{2-} < He_2^+$

30. Which of the following molecules has trigonal planar geometry? **[CBSE AIPMT 2009]**

(a) IF_3 (b) PCl_3 (c) NH_3 (d) BF_3

31. According to molecular orbital theory which of the following lists rank the nitrogen species in terms of increasing bond order? **[CBSE AIPMT 2009]**

(1) $N_2^- < N_2 < N_2^{2-}$ (2) $N_2^{2-} < N_2^- < N_2$ (3) $N_2 < N_2^{2-} < N_2^-$ (4) $N_2^- < N_2^{2-} < N_2$

(2)

According to the molecular orbital theory (MOT).

$$N_2(7+7=14) = \sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2$$

$$\overset{*}{\sigma} 2s^2, \pi 2p_x^2 = 2p_y^2, \sigma 2p_z^2$$

$$\text{Bond order} = \frac{10-4}{2} = 3$$

$$N_2^-(7+7+1=15)$$

$$= \sigma 1s^2, \overset{*}{\sigma} 1s^2, \sigma 2s^2, \overset{*}{\sigma} 2s^2,$$

$$\sigma 2p_z^2, \pi 2p_x^2 = \overset{*}{\pi} 2p_x^1 = \overset{*}{\pi} 2p_y^1$$

$$BO = \frac{10-6}{2} = 2$$

Hence, the increasing order of bond order is,

$N_2^{2-} < N_2^- < N_2$

32. Which one of the following species does not exist under normal conditions? **[CBSE AIPMT. 2010]**

(a) B_2 (b) Li_2 (c) Be_2^+ (d) Be_2

33. In which of the following pairs of molecules/ions, the central atoms have sp^2 hybridisation? **[CBSE AIPMT 2010]**

(a) NO_2^- and NH_3 (b) BF_3 and NO_2^- (c) NH_2^- and H_2O (d) BF_3 and NH_2^-

For sp^3 hybridisation there must be 3σ bonds or 2σ -bonds along with a lone pair of electrons.

i) $NO_2^- \Rightarrow 2\sigma + 1/p = 3, \text{i.e.} sp^2$ hybridization

ii) $NH_3 \Rightarrow 3\sigma + 1/p = 4, \text{i.e.} sp^3$ hybridization

iii) $BF_3 \Rightarrow 3\sigma + 0/p = 3, \text{i.e } sp^2$ hybridization

iv) $NH_2^- \Rightarrow 2\sigma + 2lp = 4 \text{i.e. } sp^3$ hybridization

v) $H_2O \Rightarrow 2\sigma + 2lp = 4, \text{i.e.} sp^3$ hybridization

Thus among the given pairs, only BF_3 and NO_2^- have sp^2 hybridisation.

34. In which one of the following species the central atom has the type of hybridization which is not the same as that present in the other three? **[CBSE AIPMT 2010]**

(a) SF_4 (b) I_3^- (c) $SbCl_5^{2-}$ (d) PCl_5

Molecules having same hybridization have same number of hybrid orbitals.

$$H = \frac{1}{2}[V + X - C + A]$$

Where,
V = number of valence electrons of central atom
C = number of monovalent atoms
A = charge on anion

$SbCl_5^{2-} = sp^3d2$, $PCl_5 = sp^3d$

$SF_4 = sp^3d, I_3^- = sp^3d$

35. Which of the following has the minimum bond length? **[AIPMT 2011]**

(a) O_2^+ (b) O_2^- (c) O_2^{2-} (d) O_2

Bond order of $O_2^+ = \frac{10-5}{2} = 2.5$

Bond order of $O_2^- = \frac{10-7}{2} = 1.5$

Bond order of $O_2^{2-} = \frac{10-8}{2} = 1$

Bond order of $O_2 = \frac{10-8}{2} = 2$

$\because$ Maximum bond order =minimum bond length

$\therefore$ Bond length is minimum for O_2^+

36. Which of the following is least likely to behave as Lewis base? **[CBSE AIPMT 2011]**

(a) NH_3 (b) BF_3 (c) OH^- (d) H_2O

BF_3 is an electron deficient species, thus behave like a Lewis acid

$\because$ Bond order $= \frac{N_b - N_a}{2}$

37. Considering the state of hybridization of carbon atoms, find out the molecule among the following which is linear? **[CBSE AIPMT 2011]**

(a) $CH_3-C\equiv C-CH_3$ (b) $CH_2=CH-CH-CH_2-C\equiv CH$

(c) $CH_3-CH_2-CH_2-CH_3$ (d) $CH_3-CH=CH-CH_3$

$\overset{4}{H_3}C-\overset{3}{C}\equiv\overset{2}{C}-\overset{1}{C}H_3$ is linear because C_2 and C_3 are sp hybridized carbon atom.

38. Which of the two ions from the list given below, have the geometry that is explained by the same hybridization of orbitals, $NO_2^-, NO_3^-, NH_2^-, NH_4^+, SCN^-$? **[CBSE AIPMT 2011]**

(a) NH_4^+ and NO_3^- (b) SCN^- nad NH_2^- (c) NO_2^- and NH_2^- (d) NO_2^- and NO_3^-

$NO_2^- \rightarrow sp^2$

$NO_3^- \rightarrow sp^2$

$NO_2^+ \rightarrow sp^3$

$NH_4^- \rightarrow sp^3$

$SCN^+ \rightarrow sp$

NO_2^- and NO_3^- both have the same hybridation i.e. sp^2.

39. The pair of species with the same bond order is **[NEET 2013]**

(a) NO, CO (b) N_2, O_2 (c) O_2^{2-}, B_2 (d) O_2^+, NO^+.

40. Which of the following is paramagnetic? **[NEET 2013]**

(a) NO^+ (b) CO (c) O_2^- (d) CN^-

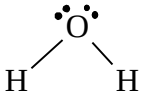
41. Which of the following is a polar molecule? **[NEET 2013]**

(a) BF_3 (b) SF_4 (c) SiF_4 (d) XeF_4

Symmetrical molecules are generally non-polar although they have polar bonds. This is because bond dipole of one bond is cancelled by that of the other. BF_3,SIF_4 and XeF_4 being symmetrical as non-polar, SF_4 is unsymmetrical because of the presence of a lone pair of electrons. Due to which it is a polar molecule.

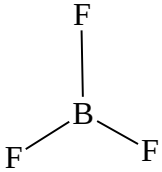
42. Which of the following species contains three bond pairs and one lone pair around the central atom? **[NEET 2013]**

(a) H_2O (b) BF_3 (c) NH_2^- (d) PCl_3

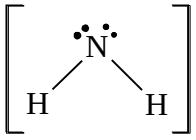


(a) $H_2O \Rightarrow$ (2bp + 2lp)

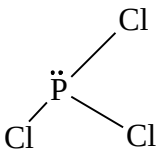
[bp = bond pair and lp = lone pair]



(b) $BF_3 \Rightarrow$ (3bp + 0 lp)



(c) NH_2^- ⇒ (2bp + 2lp)



(d) PCl_3 ⇒ (3bp + 1lp)

Thus, in PCl_3, the central P-atom is surrounded by three bond pairs and one lone pair.

43. Bond order of 1.5 is shown by **[NEET 2013]**

(a) O_2^+ (b) O_2^- (c) O_2^{2-} O_2

44. Which one of the following molecules contain no $\pi-$bond? **[NEET 2013]**

(a) CO_2 (b) H_2O (c) SO_2 (d) NO_2

All the molecules have O-atom with lone pairs, but in H_2O the H-atom has no vacant orbital for π-bonding. That's why it does not have any $\pi-$bond.

In all other given molecules, the central atom because of the presence of vacant orbitals is capable to form $\pi-$bonds.

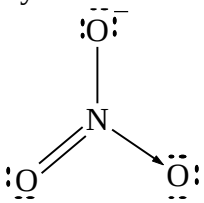
45. Which of the following molecules has the maximum dipole moment? **[CBSE AIPMT 2014]**

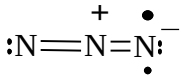
(a) CO_2 (b) CH_4 (c) NH_3 (d) NF_3

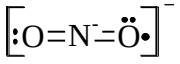
46. Which of the following species has plane triangular shape. **[CBSE AIPMT 2014]**

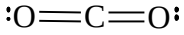
(a) N_3 (b) NO_3^- (c) NO_2^- (d) CO_2

Species with sp^2 hybridisation are planar triangular in shape. Among the given species NO_3^- is sp^2 hybridised with no lone pair of electrons on central atom, N. Whereas N_3, NO_2^- and CO_2 are sp hybridized with a linear shape.



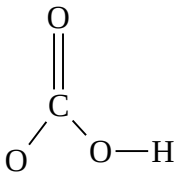
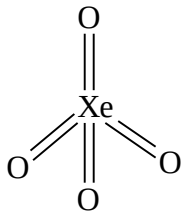
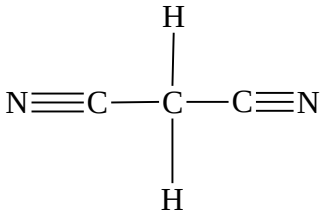






47. Which of the following species contains equal number of σ and $\pi-$bonds? **[CBSE AIPMT 2015]**

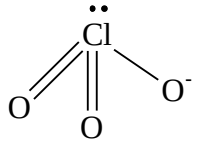
(a) HCO_3^- (b) XeO_4 (c) $(CN)_2$ (d) $CH_2(CN)_2$

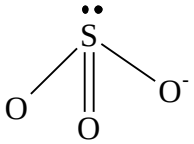
	Structure	σ and π bonds
(a)		σ bonds - 4 π bonds -1
(b)		σ bonds - 4 π bonds -4
(c)	$N \equiv C - C \equiv N$	σ bonds - 3 π bonds -4
(d)		σ bonds - 6 π bonds - 4

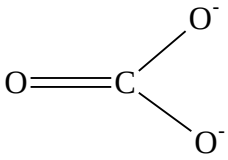
48. Which of the following pairs of ions are isoelectronic and isostructural?**[CBSE AIMPT 2015]**

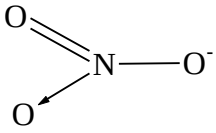
(a) CO_3^{2-}, SO_3^{2-} (b) ClO_3^-, CO_3^{2-} (c) SO_3^{2-}, NO_3^- (D) ClO_3^-, SO_3^{2-}

$ClO_3^- = SO_3^{2-}$









Number of electrons

$CO_3^{2-} = 6 + 2 + 24 = 32$

$SO_3^{2-} = 16 + 2 + 24 = 42$

$ClO_3^- = 4 + 24 + 1 = 42$

$CO_3^{2-} = 6 + 24 + 2 = 32$

$NO_3^- = 7 + 2 + 24 = 33$

Hence ClO_3^- and SO_3^{2-} are isoelectronic and are pyramidal in shape.

49. Which of the options represent the correct bonder order? **[AIPMT 2015]**

(a) $O_2^- < O_2 < O_2^+$ (b) $O_2^- > O_2 < O_2^+$ (c) $O_2^- < O_2 > O_2^+$ (d) $O_2^- > O_2 > O_2^+$

50. Predict the correct order among the following: **[NEET 2016]**

(a) lone pair – lone pair > bond pair – bond pair > lone pair – bond pair
(b) bond pair – bond pair > lone pair – bond pair > lone pair – lone pair
(c) lone pair – bond pair > bond pair – bond pair > lone pair – lone pair
(d) lone pair – lone pair > lone pair – bond pair > bond pair – bond pair

According to the postulate of VSEPR theory, a lone pair occupies more space than a bonding pair, since it lies closer to the central atom. This means that the repulsion between the different electron pairs follow the order.
Ip > lp >lp > bp > bp - bp

51. Consider the molecules CH_4, NH_3 and H_2O. Which of the given statements is false?

[NEET 2016]

(a) The H–O–H bond angle in H_2O is larger than the H–C–H bond angle in CH_4.
(b) The H–O–H bond angle in H_2O is smaller than the H–N–H bond angle in NH_3.
(c) The H–C–H bond angle in CH_4 is larger than the H–N–H bond angle in NH_3.
(d) The H–C–H bond angle in CH_4, the H–N–H bond angle in NH_3, and the H–O–H bond angle in H_2O are all greater than $90°$.

As the number of lone pair of electrons on central element increases, repulsion between those lone pair of electrons increases and therefore, bond angle decreases.

Molecules Bond angle

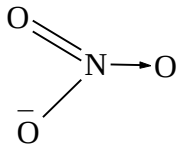
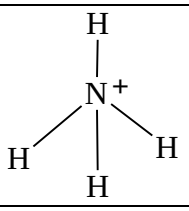
CH_4 (no lone pair of electrons) 109.5^0
NH_3 (one lone pair of electrons) 107.5^0
H_2O (two lone pair of electrons) 104.45^0

52.

53. The hybridizations of atomic orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ respectively are

[NEET 2016]

(a) sp, sp^3 and sp^2 (b) sp^2, sp^3 and sp
(c) sp, sp^2 and sp^3 (d) sp^2, sp and sp^3

Ion	Structure	Hybridisation
NO_2^+	$O{=}N^+{=}O$	Sp
NO_3^-		Sp^2
NH_4^-		Sp^3

Thus, option (C) is correct.

54. Which of the following pairs of ions is isoelectronic and isostructural? **[NEET 2016]**

(a) CO_3^{2-}, NO_3^- (b) ClO_3^-, CO_3^{2-} (c) SO_3^{2-}, NO_3^- (d) ClO_3^-, SO_3^{2-}

55. Which one of the following pairs of species have the same bond order? **[NEET 2017]**

(a) CO, NO (b) O_2, NO^+ (c) CN^-, CO (d) N_2, O_2^-

The species that have same number of electrons have same bond order.

Species	Number of electrons
CO	6+8 = 14
NO	7 + 8 =15
O_2	8 + 8 = 16
NO^+	7+8-1 =14
CN^-	6 + 7 + 1 = 14
O_2^-	8+8+1=17

Thus, both CN^- and CO have equal number of electrons. So, their bond order will be same.

56. Consider the following species: **[NEET 2018]**

CN^+, CN^-, NO and CN

Which one of these will have the highest bond order?

(a) CN^+ (b) CN (c) CN^- (d) NO

57. Which of the following diatomic molecular species has only π-bonds according to molecular orbital theory? **[NEET (National) 2019]**

(a) N_2 (b) C_2 (c) Be_2 (d) O_2

The molecular orbital configuration of C_2 is

$C_2(Z=12) = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2$.

Double bond in C_2 consists of both π-bonds because of the presence of last (valence) four electrons in two π-molecular orbitals.

The configuration of N_2, Be_2 and O_2 are as follows:

$N_2(Z=14) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2$ (1 σ and 2 π-bonds)

$Be_2(Z=8) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$ (σ bonds only)

$O_2(Z=16) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma^* 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_z^1$ (σ, π and $1\pi^*$ bond)

58. Which of the following is paramagnetic ? **[NEET (Odisha) 2019]**

(a) N_2 (b) H_2 (c) Li_2 (d) O_2

Key Idea If all the electron in a molecule are paired, the molecule is diamagnetic and if there are unpaired electrons in a molecule, it is paramagnetic.

Molecular orbital configuration of given molecules are as follows:

(a) $N_2 (Z = 14) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2$
It is a diamagnetic molecule due to absence of unpaired electron.

(b) $H_2 (Z = 2) - 1\sigma^2$
It is a diamagnetic molecule.

(c) $Li_2 (Z = 6) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2$
It is a diamagnetic molecule.

(d) $O_2 (Z = 16) - \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^1$
It is a paramagnetic molecule due to presence of unpaired electrons in each orbital of degenerate levels.
Thus, option (d) is correct.

59. Match the xenon compounds in Column I with its structure in Column II and assign the correct code : **[NEET (National) 2019]**

	Column I		Column II
A.	XeF_4	(i)	Pyramidal
B.	XeF_6	(ii)	Square planar
C.	$XeOF_4$	(iii)	Distorted octahedral
D.	XeO_3	(iv)	Square pyramidal

Codes

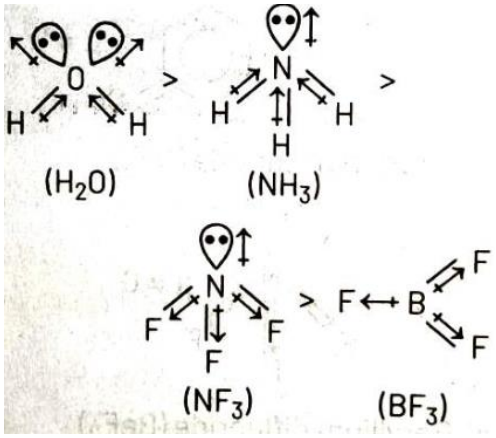
	A	B	C	D
(a)	(ii)	(iii)	(iv)	(i)
(b)	(iii)	(iii)	(i)	(iv)
(c)	(iii)	(iv)	(i)	(ii)
(d)	(i)	(ii)	(iii)	(iv)

60. Which of the following is the correct order of dipole moment? **[NEET (Odisha) 2019]**

(a) $NH_3 < BF_3 < NF_3 < H_2O$ (b) $BF_3 < NF_3 < NH_3 < H_2O$
(c) $BF_3 < NH_3 < NF_3 < H_2O$ (d) $H_2O < NF_3 < NH_3 < BF_3$

BF_3 has zero dipole moment as it is symmetrical in nature. H_2O has maximum dipole moment as it possess two line pair electrons. Between NH_3 NF_3, NH_3 and NF_3, both N possesses one lone pair of electrons.

This is because in case of NF_3 the net N – H bond dipole is in the same direction as the direction of dipole of lone pair. But in case of NF_3, the direction of net dipole moment of three – N - F bonds is opposite to that of the dipole moment of the lone pair. Thus, the correct of dipole moment is



61. Which of the following set of molecules will have zero dipole moment ? **[NEET (Sept) 2020]**

(a) Boron trifluoride, hydrogen fluoride, carbon dioxide, 1,3-dichlorobenzene
(b) Nitrogen trifluoride, beryllium difluoride, water, 1,3-dichlorobenzene
(c) Boron trifluoride, beryllium difluoride, carbon dioxide, 1, 4-dichlorobenzene
(d) Ammonia, beryllium difluoride, water, 1,4-dichlorobenzene

62.

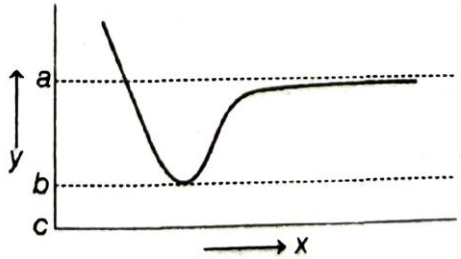
63. Identify the wrongly matched pair. **[NEET (Oct.) 2020]**

	Molecule	Shape of geometry of molecule
(a)	PCl_5	Trigonal planar
(b)	SF_6	Octahedral
(c)	$BeCl_2$	Linear
(d)	NH_3	Trigonal pyramidal

64. Identify a molecule which does not exist. **[NEET (Sep.) 2020]**

(a) Li_2 (b) C_2 (c) O_2 (d) He_2

65. The potential energy (y) curve for H, formation as a function of internuclear distance (x) of the H-atoms is shown below. **[NEET (Oct) 2020]**



The bond energy of H_2 is **[NEET (Oct.) 2020]**

(a) $(b - a)$ (b) $\frac{(c-a)}{2}$ (c) $\frac{(b-a)}{2}$ (d) $(c - a)$

From the information mentioned in the above curve, bond energy (BE) of H_2 molecule is $(b - a)$ or $|b - a|$

66. The correct sequence of bond enthalpy of 'C-X bond is **[NEET 2021]**

(a) $CH_3 - F < CH_3 - Cl < CH_3 - Br < CH_3 - I$

(b) $CH_3 - F > CH_3 - Cl > CH_3 - Br > CH_3 - I$

(c) $CH_3-F < CH_3-Cl > CH_3-Br > CH_3-I$

(d) $CH_3-Cl > CH_3-F > CH_3-Br > CH_3-I$

On moving down the group from F to I, the size of atom increases. Order of the size of halogen atoms is 1 > Br> Cl > F. So, the bond length of C – X bond also increases from F to I and hence, the bond enthalpy decreases from F to I. Correct order of bond length of C – X bond is

$H_3C-H_3C-Br > H_3C-Cl > H_3C-F$

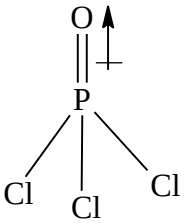
Correct order of bond enthalpy is

$H_3C - F > H_3C - Cl > CH_3 - Br > H_3C$ - I

67. Which of the following molecules is non-polar in nature? **[NEET 2021]**

(a) $POCl_3$ (b) CH_2O (c) $SbCl_5$ (d) NO_2

(a) PCl_3 Hybridisation = $\frac{1}{2}\times 8 = 4(sp^3)$



Shape = Tetrahedral

Dipole moment, $\mu \neq 0$

$POCl_3$ is polar in nature.

(b)

68. Match List-l with List-ll.

	List – I		**List – II**
A.	PCl_5	I.	Square pyramidal
B.	SF_6	II.	Trigonal planar
C.	BrF_5	III.	Octahedral
D.	BF_3	IV.	Trigonal bipyramidal

Choose the correct answer from the options given below **[NEET 2021]**

	A	B	C	D
(a)	IV	III	I	II
(b)	II	III	IV	I
(c)	III	I	IV	II
(d)	IV	III	II	I

69. BF_3 is planar and electron deficient compound. Hybridisation and number of electrons around the central atom, respectively are **[NEET 2021]**

(a) sp^3 and 4 (b) sp^3 and 6 (c) sp^2 and 6 (d) sp^2 and 8

Hybridisation of a central atom can be calculate by using the formula

Hybridisation = $\frac{1}{2}$[Number of valence electrons + Number of side atoms – Positive charge + Negative charge]

Electronic configuration of B = $1s^2, 2s^2, 2p^1$

Number of valence electrons in B = 3 electron in last shell, n = 2

Number of side atoms in BF_3 = 3F – atoms

So, hybridization = $\frac{1}{2}(3+3)=\frac{1}{2}\times 6=3$

Hybridisation of B in BF_3 is sp^2

Number of electrons around central atom, B in BF_3 is equal to the number of electrons in three sigma bonds (B – F) i.e. = 3B – F bonds $\times 2$ electrons in one σ-bond

70. Which amongst the following is INCORRECT statement? **[NEET 2022]**

(1) The bond orders of O_2^+, O_2, O_2^- and O_2^{2-} are 2.5, 2, 1.5 and 1, respectively

(2) C_2 molecule has four electrons in its two degenerate π molecular orbitals

(3) H_2^+ ion has one electron

(4) O_2^+ ion is diamagnetic

O_2^+ has one unpaired electron.

71. Amongst the following which one will have maximum 'lone pair–lone pair' electron repulsions? **[NEET 2022]**

(1) IF_5 (2) SF_4 (3) XeF_2 (4) ClF_3

(3)

No. of	lone pair	molecule
	1	IF_5
	2	SF_4
	3	XeF_2
	2	ClF_3

72. Identify the incorrect statement from the following. **[NEET 2022]**

(1) All the five 4d orbitals have shapes similar to the respective 3d orbitals.

(2) In an atom, all the five 3d orbitals are equal in energy in free state.

(3) The shapes of d_{xy}, d_{yz}, and d_{zx} orbitals are similar to each other; and $d_{x^2-y^2}$ and d_{z^2} are similar to each other.

(4) All the five 5d orbitals are different in size when compared to the respective 4d orbitals.

The shapes of dxy, dyz, dzx and dx^2y^2 are similar to each other.

73. Given below are two statements: **[NEET 2022]**

Statement I:

The boiling points of the following hydrides of group 16 elements increases in the order–

$H_2O < H_2S < H_2Se < H_2Te$.

Statement II:

The boiling points of these hydrides increase with increase in molar mass.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are incorrect

(2) Statements I is correct but Statement II is incorrect

(3) Statement I is incorrect but statement II is correct

(4) Both Statement I and Statement II are correct

$H_2O(100°C)$ $H_2S(-60°C)$

$H_2Se(-41.25°C)$ $H_2Te(-2.2°C)$

74. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). **[NEET 2022]**

Assertion (A): ICl is more reactive than I_2.

Reason (R): $I-Cl$ bond is weaker than $I-I$ bond.

In the light of the above statements choose the most appropriate answer from the options given below:

(1) Both (A) and (R) are correct but (R) is not the correct explanation of (A).

(2) (A) is correct but (R) is not correct.

(3) (A) is not correct but (R) is correct.

(4) Both (A) and (R) are correct and (R) is the correct explanation of (A)

ICl is more reactive than I_2 due to ionic character of the bond.

76. Which of the following statements is not correct about diborane? **[NEET 2022]**

(1) The four terminal B–H bonds are two centre two electron bonds.

(2) The four terminal Hydrogen atoms and the two Boron atoms lie in one plane.

(3) Both the Boron atoms are sp^2 hybridized.

(4) There are two 3–centre–2–electron bonds.

In diborane both the boron atoms are sp^3 hybridised