Chemical Bonding and Molecular Structure

SOLUTIONS

EXERCISE - O

1. Ans. (A)

Energy is released on combination of two atoms to form a molecule.

2. Ans. (C)

Hydrogen Bond, as energy release is between 8 to 42 kJ/mol.

3. Ans. (A)

Element	Electrons in outermost orbit
A	3
B	6
Ions formed	$A \rightarrow A^{3\oplus}$
	$B \rightarrow B^{2\ominus}$
Compound formed	$A^{3\oplus} + B^{2\ominus}$
	A_2B_3

4. Ans. (A)

Lattice enthalpy is the change in energy that occurs when one mole of an ionic solid is separated into isolated ions in the gas phase.

5. Ans. (D)

Ionic bond formation involves formation of octets

6. Ans. (B)

Lattice energy $\propto$ |Product of charges|

$$\propto \frac{1}{\text{Internuclear distance (r)}} \propto \frac{1}{r^{\oplus} + r^{\ominus}}$$

r is smallest for NaF. Hence, NaF will show highest lattice energy.

7. Ans. (A)

$$\text{Lattice energy} \propto \frac{1}{\text{Internuclear distance (r)}}$$

Internuclear distance varies as :-

LiF < LiCl < LiBr < LiI

Lattice energy order : LiF > LiCl > LiBr > LiI

8. Ans. (B)

E.N. of Cesium = 0.7

E.N. of Fluorine = 4.0

Electronegativity difference, $\Delta EN = 4.0 - 0.7 = 3.3$

If ΔE.N. >2.1, the bonds formed are ionic.

9. Ans. (A)

High melting point and non – directional bonds.

10. **Ans. (A)**

X is electropositive univalent, so formed cation : $X^{\oplus}$

Y is electronegative univalent, so formed anion : $Y^{\ominus}$

Formula of the compound would be : $X^{\oplus}Y^{\ominus}$

11. **Ans. (B)**

$$\text{Lattice energy (LE)} \propto \frac{|\text{Product of charges}(q_1q_2)|}{\text{Internuclear distance (r)}}$$

Product of charges dominates over internuclear distance. Hence, BaO and CaO have more L.E. than NaCl and NaBr.

Also, L.E. of CaO > BaO and NaCl > NaBr

Overall order : NaBr < NaCl < BaO < CaO

12. **Ans. (C)**

Electron transfer is possible only in such cases.

13. **Ans. (A)**

Greater electronegativity difference favours ionic bond formation.

14. **Ans. (B)**

Lattice energy of an ionic compound is preferably high, so Ionic bond is a strong bond.

15. **Ans. (D)**

Bigger the size of ions, lower is lattice energy.

16. **Ans. (C)**

Valencies of L, Q, P and R is – 2, – 1, + 1 and + 2 respectively so they will form P_2L, RL, PQ and RQ_2

17. **Ans. (B)**

An ionic bond $A^{\oplus}B^{\ominus}$ is most likely to be formed when Ionization energy of A is low, because $A^{\oplus}$ will formed easily and Electron gain enthalpy of B is high, because $B^{\ominus}$ will formed easily

18. **Ans. (C)**

$CaCl_2$ is an ionic compound whereas CH_4, H_2O and NH_3 are covalent.

19. **Ans. (D)**

One covalent bond contains = $2e^{\ominus}$

Then, triple bond contains = $2 \times 3 = 6e^{\ominus}$

20. **Ans. (B)**

Covalent bond is formed by combination of half filled orbitals.

21. **Ans. (C)**

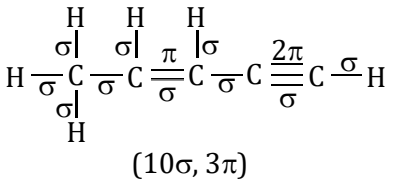
In allene structure we have :

$$H_2C \overset{1\pi}{\underset{1\sigma}{=}} C \overset{1\pi}{\underset{1\sigma}{=}} CH_2$$

Hence, three carbon atoms are joined by two sigma bond and two π bond.

22. **Ans. (A)**

Given :-



$(10\sigma, 3\pi)$

23. **Ans. (C)**

(A) $C_2H_4Cl_2$ → All bonds are covalent.

(B) CH_3I → All bonds are covalent.

(C) $K^{\oplus}\left[\overset{\ominus}{C} \equiv N\right]$ → covalent bond and ionic bond

(D) H_2O_2 → All bonds are covalent.

24. **Ans. (C)**

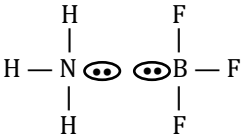
In co-ordinate bond formation, the acceptor atom must contain an empty orbital in its valence shell.

25. **Ans. (D)**

(A) $(C_2H_5)_3B$ and $(CH_3)_3\ N:$

Empty orbital present

Lone pair for donation present



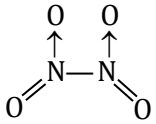
(C) F_3B and $:NH_3$

So, 1 and 3 can form coordinate bond.

(B) HCl and HBr → Cannot form coordinate bond.

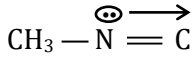
26. **Ans. (D)**

Both covalent & coordinate present

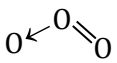


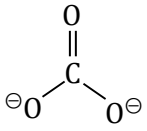
Structure of N_2O_4

27. **Ans. (D)**

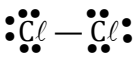
A. 

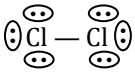
B. 

C. 

D.  No Coordinate Bond

28. **Ans. (A)**

Chlorine molecule (Cl_2) : 



Total number of lone pairs = 6

29. **Ans. (C)**

In N_2 molecule each Nitrogen atom contribute $3e^{\ominus}$ so total no. of electron's are 6.

30. **Ans. (C)**

NH_3 has lone pair of electron while BF_3 is electron deficient compound so they form a co-ordinate bond. $NF_3 \rightarrow BF_3$

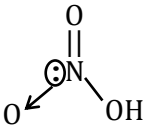
31. **Ans. (A)**

$SO_3^{2\ominus}$ has one coordinate bond. $^{\ominus}O-\underset{\underset{O}{\downarrow}}{S}-O^{\ominus}$

32. **Ans. (D)**

Co-ordinate bond is a special type of covalent bond which is formed by sharing of electrons between two atoms, where both the electrons of the shared pair are contributed by one atom. Since this type of sharing of electrons exits in O_3, SO_3 and H_2SO_4. Therefore, all these contains coordinate bond

33. **Ans. (B)**



Number of dative bond = 1

34. **Ans. (A)**

Covalent in CCl_4 and electrovalent in CaH_2 ($Ca^{2\oplus}$ $2H^{\ominus}$)

35. **Ans. (D)**

Carbon has no vacant d – orbitals and cannot exceed its octet.

36. **Ans. (A)**

According to LDS, dative bond is present in

37. **Ans. (B)**

$Pb^{4\oplus}$: [Xe] $4f^{14}$ $5d^{10}$

Nitrogen contains 5 electrons in its valence shell and after getting 3 electrons its octet is Complete.

38. **Ans. (D)**

Hydrogen always completes its duplet.

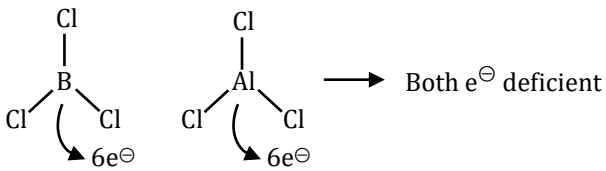
39. **Ans. (D)**

Octet is incomplete for aluminium in $AlCl_3$ as it is electron deficient (Hypovalent).

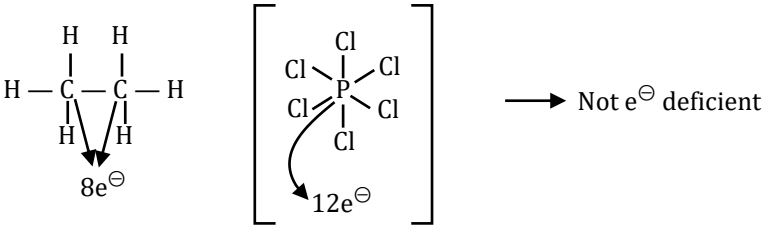
40. **Ans. (A)**

Electron deficient compounds :

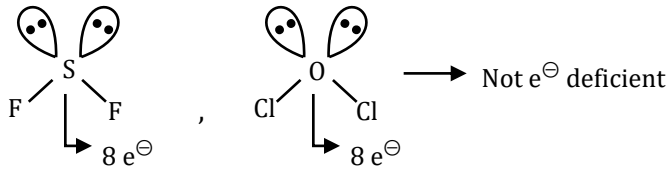
(A) BCl_3, $AlCl_3$



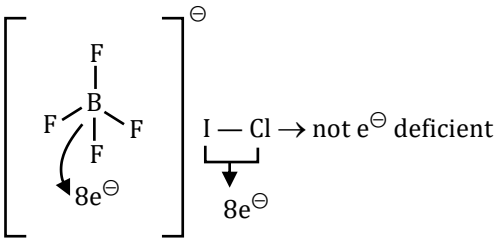
(B) C_2H_6, $PCl_6^{\ominus}$



(C) SF_2, Cl_2O

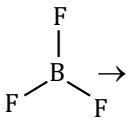


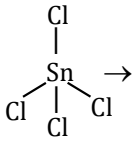
(D) $BF_6^{\ominus}$, ICl



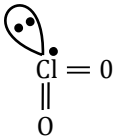
Option A contains e- deficient compounds.

41. Ans. (B)

(A) BF_3 →  → $6e^{\ominus}$ (exception)

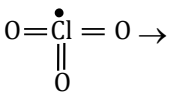
(B) $SnCl_4$ →  → $8e^{\ominus}$ Complete octet (Not an exception)

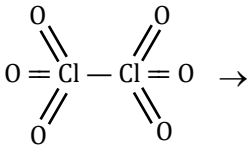
(C) BeI_2 → I — Be — I ($4e^{\ominus}$) → (exception)

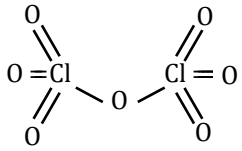
(D) ClO_2 →  Odd $e^{\ominus}$ species (exception)

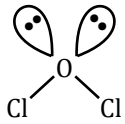
[B] is not an exception

42. Ans. (A)

(A) ClO_3 →  → odd $e^{\ominus}$ molecule

(B) Cl_2O_6 →  → not an odd $e^{\ominus}$ molecule

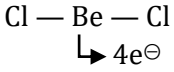
(C) Cl_2O_7 →  not an odd $e^{\ominus}$ molecule

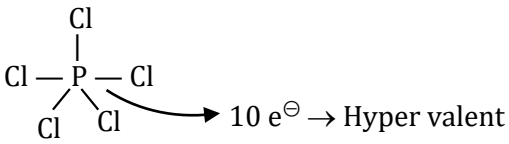
(D)  Not an odd $e^{\ominus}$ molecule

[A] is odd $e^{\ominus}$ molecule

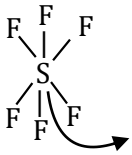
43. Ans. (A)

Hypovalent species are :-

(A) $BeCl_2$  → Hypovalent

(B) PCl_5 →  → 10 $e^{\ominus}$ → Hyper valent

(C) $CO_2 \rightarrow O = C = O \rightarrow$ Complete octet

(D) SF_6 →  12 $e^{\ominus}$ → Hyper valent

44. Ans. (B)

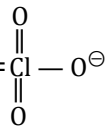
Molecule/ Ion	Valence e- at central atom
1) PCl_5	10
2) BF_3	6
3) XeF_2	10
4) $CO_3^{2\ominus}$	8

45. Ans. (A)

NaOCl is ionic compound which can't be represented as given in option (A). This must be present in the form of cation and anion as $Na^{\oplus}\,O^{\ominus}-Cl$

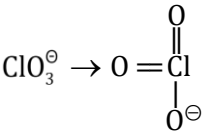
46. Ans. (C)

Bond strength α Bond order

A. $ClO_4^{\ominus} \rightarrow$  ; B.O. = 1.75

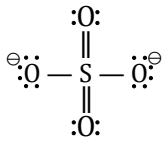
B. $ClO_2^{\ominus} \rightarrow O{=}Cl - O^{\ominus}$; B.O. = 1.5

C. $ClO^{\ominus} \rightarrow Cl - O^{\ominus}$; B.O. = 1

D.  ; B.O. = 1.67

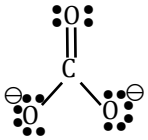
(C) $\rightarrow$ has smallest bond order so, (C) has weakest Cl — O bond.

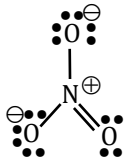
47. Ans. (A)

 Bond order = 1.5

Charge on each oxygen = –0.5, because –2 charge is distributed on 4 oxygen.

48. Ans. (D)

(A) $CO_3^{2\ominus}$ $\rightarrow$  shows resonance

(B) $NO_3^{\ominus}$ $\rightarrow$  shows resonance

(C) O_2 $\rightarrow$  no resonance

Both (A) and (B) shows resonance.

49. Ans. (C)

Due to resonance, Bond order of O_3 is 1.5, so x will be between 121 pm and 148 pm.

50. Ans. (B)

Resonance is due to delocalization of pi electrons

51. Ans. (C)

In resonating structures there should be the same number of electron pairs.

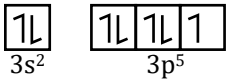
52. Ans. (A)

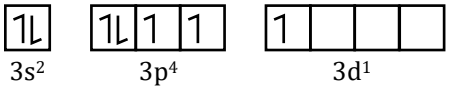
Variable covalency is exhibited by P, S and Cl due to presence of vacant 3d orbitals.

Hence, answer will be P and S.

53. Ans. (C)

$ClF_3 \Rightarrow$ Cl : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ 3d^0$

Cl : [Ne] 
$3s^2$ $3p^5$

Cl* : [Ne]  (1st excitation state)
$3s^2$ $3p^4$ $3d^1$

Chlorine can form 3 bond in 1^{st} excitation state.

54. **Ans. (C)**

XeF_5

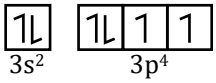
As there are 8 electrons in valence shell of Xe, after forming 5 bonds, 3 electrons are remaining. So it is not possible according to VBT.

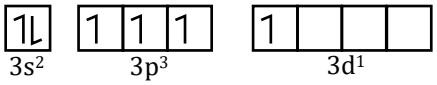
55. **Ans. (B)**

Nitrogen does not contain vacant d-orbitals.

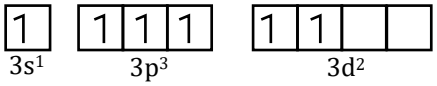
56. **Ans. (B)**

S :[Ne]$3s^2\ 3p^4$

S : [Ne) 

S* : [Ne] 

(1st excitation state)

S** : [Ne] 

(2st excitation state)

57. **Ans. (D)**

(A) s – s overlapping (B) s – p overlapping

(C) s – p overlapping (D) p – p overlapping

58. **Ans. (C)**

A sigma bond is formed by the overlapping of s - s, s - p, p - p orbitals along internuclear axis.

H — Cl

$1s^1$ $[Ne]3s^2\ 3p^5$

59. **Ans. (A)**

As p is more directional, 'σ' bond is more strong.

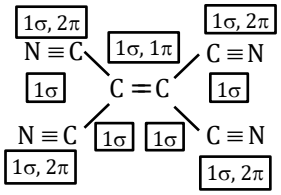
60. **Ans. (B)**

Maximum number of bonds that can be formed between two non-metals are 3 which include 1σ and 2π bond.

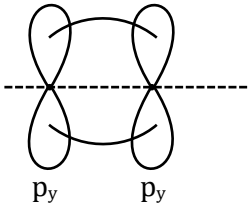
61. **Ans. (C)**

N_2	CO
$N \equiv N$	$C \equiv \overset{\oplus}{O}$
$\sigma \Rightarrow 1$	$\sigma \Rightarrow 1$
$\pi \Rightarrow 2$	$\pi \Rightarrow 2$

62. **Ans. (A)**



63. **Ans. (B)**



---------- x - axis ($p_y + p_y$ forms π – bond along x – axis)

$s + p_x$ forms σ – bond along x – axis.

$p_x + p_x$ forms σ – bond along x – axis.

$p_y + p_z$ forms no bond along x – axis.

64. Ans. (C)

$d_{yz} + d_{yz}$ along y – axis, forms π–bond.

$d_{yz} + d_{yz}$ along z – axis, forms π–bond.

$d_{yz} + d_{yz}$ along x – axis, forms δ–bond.

$d_{xz} + d_{xz}$ along x – axis, forms π–bond.

65. Ans. (B)

σ bonds are stronger than π bonds because of effective orbital overlapping along the internuclear axis.

So, option (B) is incorrect.

66. Ans. (B)

In phosphorus, 3pπ – 3pπ bond is very weak. so, it exists as P_4.

67. Ans. (B)

As value of 'n' increases. Bond strength decreases hence bond energy decreases.

68. Ans. (C)

Bond strength order :

2p - 2p > 2s - 2p > 2s - 2s

(directional) (non – directional)

69. Ans. (A)

$$\text{Bond strength} \propto \frac{1}{\text{n}-\text{value}}$$

So, for 1s - 1s bond formed is strongest

70. Ans. (C)

(I) Correct : Two s - orbitals on overlapping form σ – bond.

(II) Incorrect : Because axial overlap of two pi - orbitals form π - bond.

(III) Incorrect : Because σ-bond is stronger than π - bond.

71. Ans. (B)

(A) F-F (B) N ≡ N (C) O = O

As bond order ↑ Bond energy also ↑ thus bond energy of N_2 is max amongst these.

72. Ans. (A)

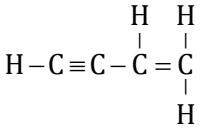
(A) d_{xy} and d_{xy} orbital of two atoms form π –bond along y axis

(B) p_z and p_z orbital of two atoms form π-bond along y- axis

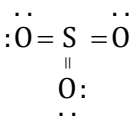
(C) $d_{x^2-y^2}$ and $d_{x^2-y^2}$ orbital of two atoms form σ -bond

(D) p_y and d_{zx} orbital of two atoms does not form any bond

73. Ans. (B)



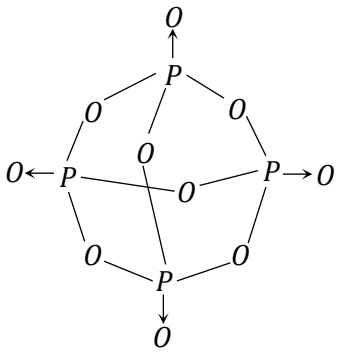
74. Ans. (D)



5 atoms has 12 electrons in its outermost shell. One $(S-O)\pi$ bond will be (p-p) π bond while two $(S-O)\pi$ bond will be (p-d) π bond.

75. Ans. (D)

Structure of P_4O_{10} is



Each phosphorus is attached to 4 oxygen atoms.

76. Ans. (A)

%s ↑	B.L.	↓
	B.S.	↑
	B.A.	↑
	E.N.	↑

77. Ans. (C)

%s ↑	B.L.	↓
	B.S.	↑
	B.A.	↑
	E.N.	↑

78. Ans. (C)

$CH_4 \rightarrow sp^3$

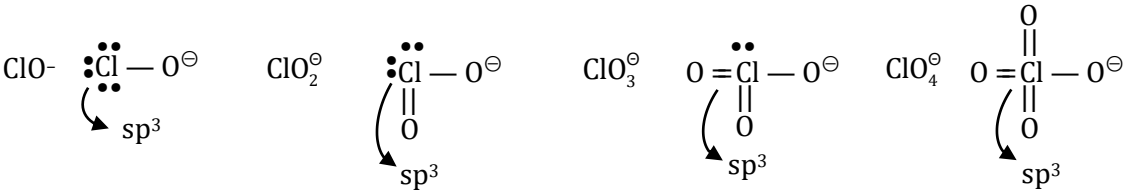
s = 1/4, p = 3/4

%s = 25%, %p = 75%

79. Ans. (C)

The number of hybrid orbitals generated is equal to number of pure atomic orbitals involved in hybridization.

80. Ans. (C)



Hybrid orbital = (no of σ - bond + no. of l.p.) on central atom.

81. **Ans. (B)**

In C_2H_6 (ethane), 'C' is sp^3

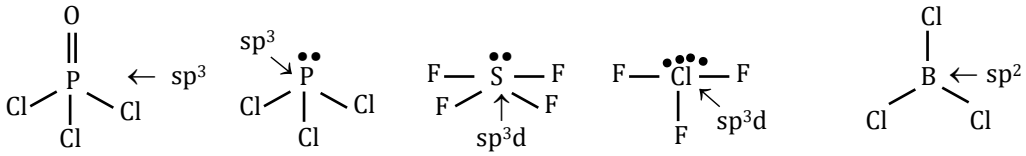
In C_2H_4 (ethylene), 'C' is sp^2

In C_2H_2 (acetylene), 'C' is sp.

B.L. order $sp^3 > sp^2 > sp$

82. **Ans. (A)**

$POCl_3$ PCl_3 SF_4 ClF_3 BCl_3



83. **Ans. (A)**

$BeCl_2$	BCl_3	CCl_4	SF_6
sp	sp^2	sp^3	sp^3d^2

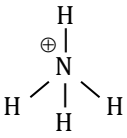
Adjacent bond angle order : $sp^3d^2 < sp^3 < sp^2 < sp$

84. **Ans. (A)**

Cl — Hg — Cl : Hybridisation → sp

85. **Ans. (C)**

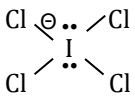
(A) $NH_4^{\oplus}$



B.P. = 4

L.P. = 0

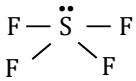
(B) $ICl_4^{\oplus}$



B.P. = 4

L.P. = 2

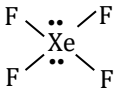
(C) SF_4



B.P. = 4

L.P. = 1

(D) XeF_4



B.P. = 4

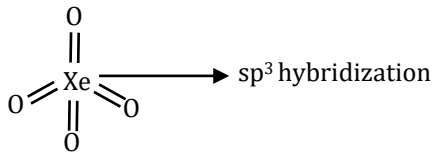
L.P. = 2

86. **Ans. (B)**

Reason : No vacant d orbital in carbon and Boron.

87. **Ans. (B)**

$XeO_4 \Rightarrow$



All p - orbitals of Xe are involved in sp^3 hybridisation. So, π - bonds are formed by Xe through d - orbitals.

'O' forms π - bond by its p-orbitals.

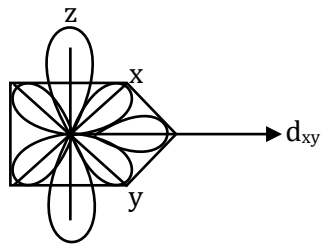
So, all the π - bonds in XeO_4 are formed by pπ - dπ overlapping.

Number of pπ - dπ bond in XeO_4 = [4]

88. **Ans. (B)**

Atomic orbitals involved are : s, p_x, p_y, p_z, $d_{x^2-y^2}$, d_{z^2}

89. **Ans. (B)**



Atomic d-orbitals involved are : $d_{x^2-y^2}, d_{z^2}, d_{xy}$

90. **Ans. (A)**

%s- character ↑ in hybrid orbital, electronegativity also ↑ because %s character ↑, hybrid orbital becomes closer to the nucleus and then tendency to pull the bonded e-↑

In sp hybrid orbital %s character is 50%

In sp^2 hybrid orbital %s character is 33%

In sp^3 hybrid orbital %s character is 25%

Thus correct E.N. order is $sp > sp^2 > sp^3$

E.N. of sp hybrid orbital is 3.25

E.N. of sp^2 hybrid orbital is 2.8

E.N. of sp^3 hybrid orbital is 2.5

91. **Ans. (C)**

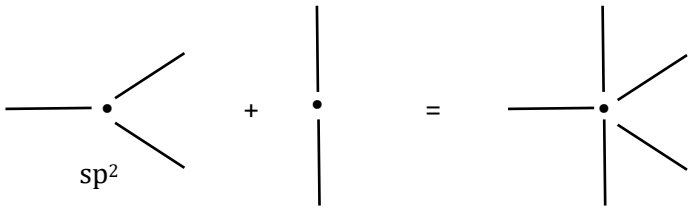
(A) $\underline{Xe}F_2 \rightarrow sp^3d$

(B) $\underline{Xe}F_4 \rightarrow sp^3d^2$

(C) $\underline{P}OCl_3 \rightarrow sp^3$

(D) $\underline{I}F_5 \rightarrow sp^3d^2$

92. **Ans. (C)**



93. **Ans. (A)**

lp – lp > lp – bp > bp – bp

94. **Ans. (C)**

Hybridisation in SF_4 is sp^3d with 1 lone pair.

95. **Ans. (B)**

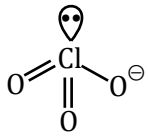
SO_2 is Bent

BF_3 is trigonal planar

PCl_5 is trigonal bipyramidal

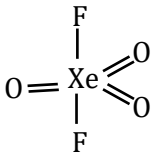
SF_6 is square bipyramidal

96. Ans. (B)



Pyramidal (sp^3)

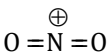
97. Ans. (B)



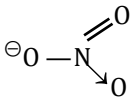
Trigonal bipyramidal

98. Ans. (C)

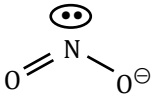
(A) $NO_2^{\oplus}$ $NO_3^{\ominus}$ $NO_2^{\ominus}$



sp

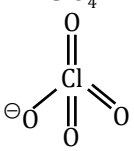


sp^2

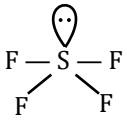


sp^2

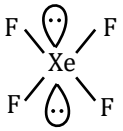
(B) $ClO_4^{\ominus}$ SF_4 XeF_4



sp^3

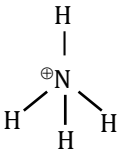


sp^3d

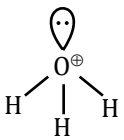


sp^3d^2

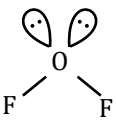
(C) $NH_4^{\oplus}$ $H_3O^{\oplus}$ OF_2



sp^3
Tetratedral

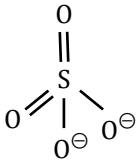


sp^3
Pyramidal

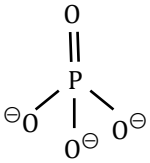


sp^3
Bent

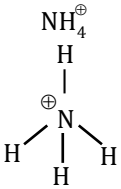
(D) $SO_4^{2\ominus}$ $PO_4^{3\ominus}$ $NH_4^{\oplus}$



sp^3
Tetrahedral

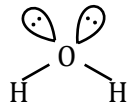


sp^3
Tetrahedral

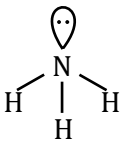


sp^3
Tetratedral

99. Ans. (D)



H_2O



NH_3

Due to two lone pairs of electrons on oxygen atom repulsion increases.

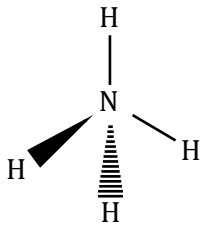
100. Ans. (A)

$CH_3^{\oplus} \rightarrow sp^2$ (trigonal planar)

$NH_3^{2\oplus} \rightarrow sp^2$ (trigonal planar)

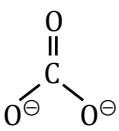
NH_3 and PCl_3 are pyramidal which is non – planar.

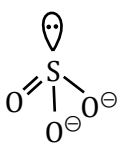
101. Ans. (C)

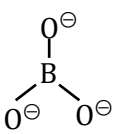


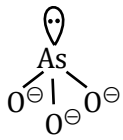
102. Ans. (B)

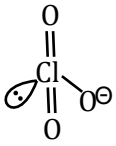
Non - planar species are present in :

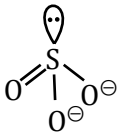
(A) $CO_3^{2\ominus}$  Planar

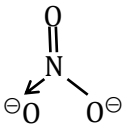
$SO_3^{2\ominus}$  Non - planar

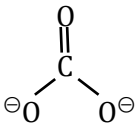
$BO_3^{3\ominus}$  Planar

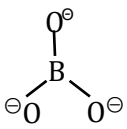
(B) $AsO_3^{3\ominus}$  Non - planar

$ClO_3^{2\ominus}$  Non - planar

$SO_3^{2\ominus}$  Non - planar

(C) $NO_3^{\ominus}$ 

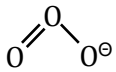
$CO_3^{2\ominus}$ 

$BO_3^{3\ominus}$ 

All planar

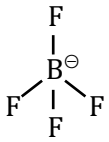
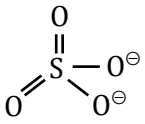
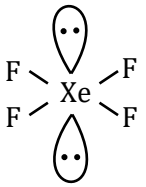
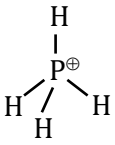
(D) $SO_3^{2\ominus}$ Non-planar $NO_3^{\ominus}$ Planar $BO_3^{3\ominus}$ Planar

103. Ans. (D)



Formal charge = 0, +1, –1

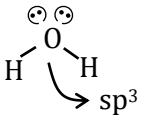
104. Ans. (C)

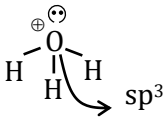
(A) $BF_4^{\ominus}$	(B) $SO_4^{2\ominus}$	(C) XeF_4	(D) $PH_4^{\oplus}$
			
sp^3 Tetrahedral	sp^3 Tetrahedral	sp^3d^2 sq. planar	sp^3 Tetrahedral

105. Ans. (C)

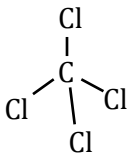
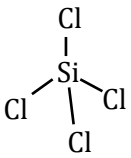
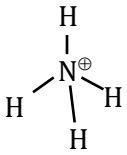
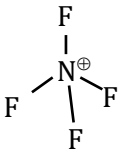
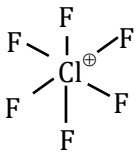
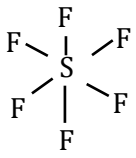
The structure of XeF_6 in vapour phase is capped octahedral or distorted octahedral.

106. Ans. (B)

H_2O  Bent/V-shape

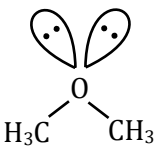
$H_3O^{\oplus}$  Trigonal pyramidal

107. Ans. (D)

A	CCl_4 	sp^3 Bond angle = 109°28'	$SiCl_4$ 	sp^3 Bond angle = 109°28'
B	$NH_4^{\oplus}$ 	sp^3 Bond angle = 109°28'	$NF_4^{\oplus}$ 	sp^3 Bond angle = 109°28'
C	$ClF_6^{\oplus}$ 	sp^3d^2 Bond angle = 90°180°	SF_6 	sp^3d^2 Bond angle = 90°, 180°

108. Ans. (C)

In dimethyl ether bond angle C-O-C is $\cong 110°$ because in (CH_3OCH_3) repulsion between bulky $-CH_3$ group is more due to which bond angle increases.



sp^3, hybridization

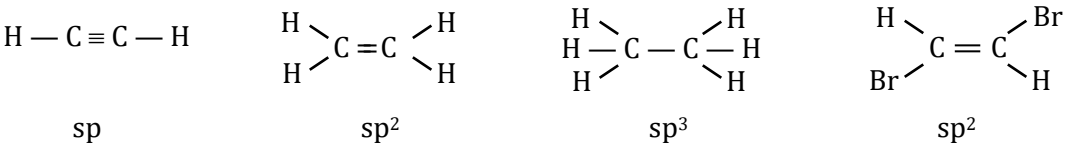
109. Ans. (C)

Cationic part of $PCl_5 \rightarrow PCl_4^{\oplus}$ (sp^3)

$PBr_5 \rightarrow PBr_4^{\oplus}$ (sp^3)

Angle difference = 0

110. Ans. (C)



sp	sp^2	sp^3	sp^2
50% s character	33% s character	25% s character	33% s character

Due to least %s character in C-H Bond in C_2H_6, C-H bond is longest in C_2H_6

As %s character ↓ bond length ↑ because p character ↑

111. Ans. (B)

P–O > S–O > Cl–O (Bond length order)

As size of atom ↓, bond length also ↓ because internuclear distance also↓

Across the period from left to right size ↓ hence bond length order is P–O > S–O > Cl–O

P > S > Cl (size order)

112. Ans. (A)

when %s character Hybrid orbital ↓

I. Bond angle ↓ (bond angle ∝ %s character)

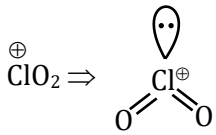
II. Bond strength ↓ (bond strength ∝ %s character)

III. Bond length ↑, because %p character ↑

IV. Size of orbital increases due to ↑ in p character

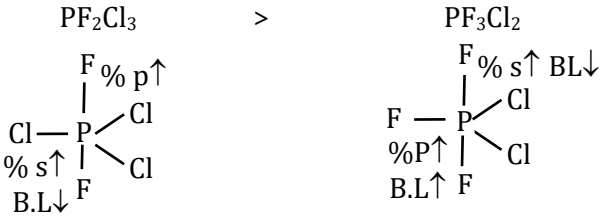
113. Ans. (C)

in solid state Cl_2O_6 exist as $ClO_2^{\oplus}$ and $ClO_4^{\ominus}$



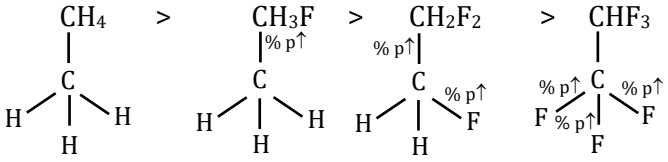
sp^2 hybridization

114. Ans. (B)



$$\%s \propto \propto \frac{1}{(B.L.)} \propto B.A$$

115. Ans. (A)



As number of Fluorine atoms increases then % p character in C – H bond decreases, hence B.L. decreases.

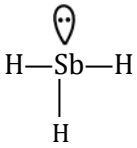
116. Ans. (D)

SbH_3

Total %s character in Sb-H bonds = 1 + 1 + 1 = 3%

Total %p character in Sb-H bonds = 100 – 3 = 97%

%p character in l.p. = 3% and %s character in l.p. = 97%



117. Ans. (C)

The lone pair of electron of NH_3 occupies sp^3 orbital and is more directional.

118. Ans. (C)

all the given molecules have same bond order of C-C bond but in $FCH_2 - CH_2F$ least number of most electronegative element F, thus %s character in C-C bond will be least amongst all because if more no of F atoms present then %s in C-F bond will be less and %s in C-C bond will be more.

%s character ↓ Bond Length ↑

119. Ans. (B)

Order of Bond Angle	%s character in bond	%p character in bond
(A) $SiH_4 = CH_4$	$SiH_4 = CH_4$	$SiH_4 = CH_4$
(B) $H_2S < H_2O$	$H_2S < H_2O$	$H_2S > H_2O$
(C) $PH_4^{\oplus} > PH_3$	$PH_4^{\oplus} > PH_3$	$PH_4^{\oplus} < PH_3$
(D) $NH_3 > PH_3$	$NH_3 > PH_3$	$NH_3 < PH_3$

If %s character in bond is higher then %p character in bond will be less.

Bond angle $\propto$ %s character

120. Ans. (C)

(A) $PH_3 \rightarrow$ No hybridisation observed

(B) $NH_3 \rightarrow sp^3$

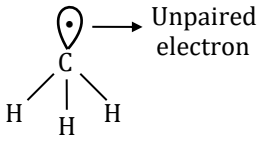
(C) $\overset{\oplus}{C}H_3 \rightarrow sp^2$

(D) $SbH_3 \rightarrow$ No hybridisation observed

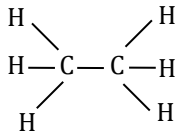
121. Ans. (D)

(A) $2CH_3 \longrightarrow C_2H_6$

Paramagnetic

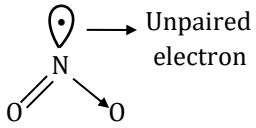


Diamagnetic

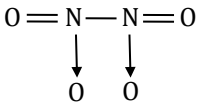


no unpaired electron

(B) $2NO_2 \longrightarrow N_2O_4$

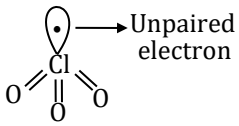


Paramagnetic

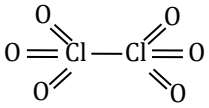


Diamagnetic

(C) $2ClO_3 \longrightarrow Cl_2O_6$

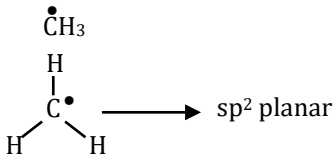


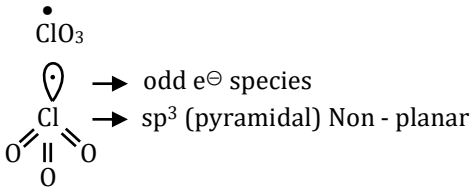
Paramagnetic

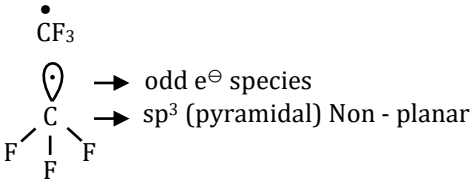


Diamagnetic

122. Ans. (A)

(A) 

(B) 

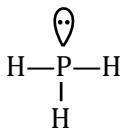
(C) 

123. Ans. (A)

$BF_6^{3\ominus}$ do not exist because Boron does not have d - orbitals in valence shell, hence max. covalency of Boron can not exceed 4. Thus, boron is unstable to form $BF_6^{3\ominus}$ ion.

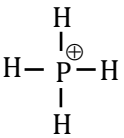
124. Ans. (D)

(A) PH_3



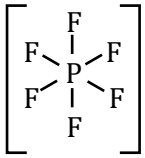
Phosphine

(B) $PH_4^{\oplus}$



Phosphonium ion

(C) $[PF_6^{\ominus}]$



Phosphorous
Hexa flouride

125. Ans. (C)

PH_5, do not exists due to absence of d-orbital contraction

126. Ans. (B)

(B) $BeF_4 \Rightarrow$ four unpaired electrons needed to form bond with 4 F atoms but

Be $\Rightarrow$ [He]$2s^2$

Only two unpaired electrons are present in Be atom in excited state and It can form only 2 bonds.

So BeF_4 is non-existing species.

127. Ans. (D)

(A) $XeH_2 \Rightarrow XeH_2$ does not exist because 'H' atom is not capable of contracting 'd' orbitals of Xenon due to less EN

(B) $ClF_7 \Rightarrow ClF_7$ does not exist because Cl cannot accommodate 7 F atoms around it. (Steric Crowding)

(C) $PH_5 \Rightarrow PH_5$ does not exist because 'H' atom is not capable of contracting 'd' orbitals of phosphorous due to less EN

(D) $ICl_3 \Rightarrow$ iodine can expand its octet and form three bonds. ICl_3 is existing specie.

128. Ans. (C)

Statement - I – True

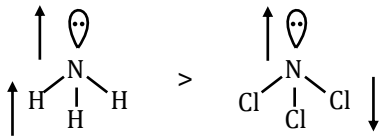
Statement - II – false

Because on the basis of d - orbital contraction

129. Ans. (B)

This is because P has vacant d-orbital orbitals due to which, it can expand its octet whereas N cannot expand its octet because d-orbitals are absent.

130. Ans. (B)

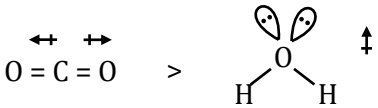


$\mu \neq 0$ $\mu \neq 0$

In NH_3, N is more electronegative than H atom so, N pull the $e^{\ominus}$ from H atom towards itself. So, the direction of the dipole moment is in the same direction as that of the lone pair of nitrogen atom.

131. Ans. (C)

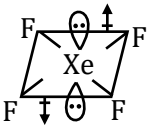
CO_2



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

132. Ans. (A)

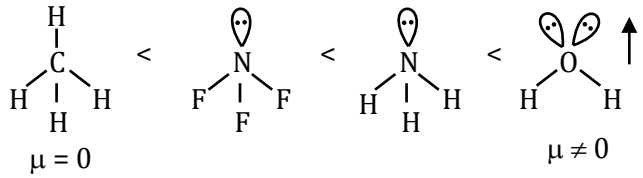
XeF_4



$\mu = 0$

133. Ans. (A)

$CH_4 < NF_3 < NH_3 < H_2O$



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

In H_2O E.N. difference high and CH_4 is symmetrical tetrahedral structure and dipole moment is zero.

134. Ans. (B)

H – F

Flourine is more electronegative so it pulls more shared pair of electrons from H.

135. Ans. (C)

$$\% \text{ ionic character} = \frac{\mu_{exp}}{\mu_{cal}} \times 100$$

$\mu_{exp} = 1.03\ D = 1.03 \times 3.33 \times 10^{-30}$ C.m

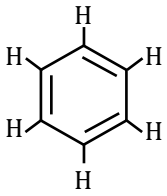
$\mu cal = q \times d = 1.6 \times 10^{-19} \times 1.275 \times 10^{-10}$

$= 1.6 \times 1.275 \times 10^{-29}$ C.m

$$\% \text{ I.C.} = \frac{1.03 \times 3.33 \times 10^{-30}}{1.6 \times 1.275 \times 10^{-29}} \times 100 = 16.81 \simeq 17\%$$

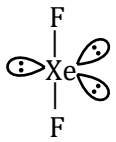
137. Ans. (D)

(A) C_6H_6



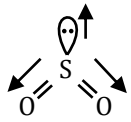
$\mu = 0$ Non polar

(B) XeF_2



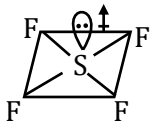
$\mu = 0$ Non polar

(C) SO_2



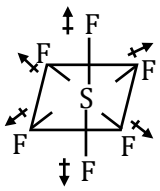
$\mu \neq 0$ Polar

(D) SF_4



$\mu \neq 0$; Polar

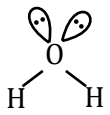
(E) SF_6



$\mu \neq 0$ Non polar

137. Ans. (B)

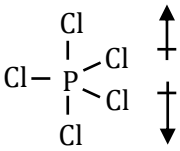
H_2O



$\mu \neq 0$ Polar

138. Ans. (B)

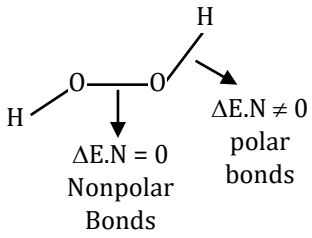
PCl_5



$\mu = 0$ Non polar

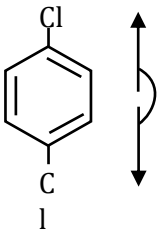
139. Ans. (C)

H_2O_2



140. Ans. (B)

P – dichloro benzene

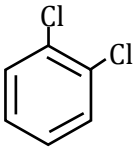


180°

$\theta = 180°$

$\cos\theta = (\downarrow)\ \mu = 0$

O - dichlorobeunzene

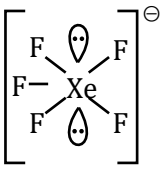


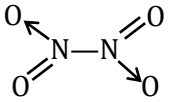
$\theta = 60°$

$\cos\theta = (\uparrow)\ \mu \neq 0$

141. Ans. (B)

Sol. $XeF_5^{\ominus}$ N_2O_4

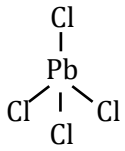


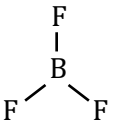


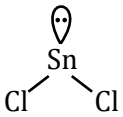
dimer of NO_2

142. Ans. (C)

$PbCl_4$ BF_3 $SnCl_2$ CS_2

(i)  $\mu = 0$

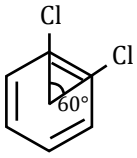
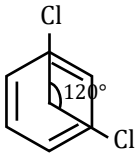
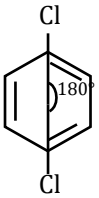
(ii)  $\mu = 0$

(iii)  $\mu \neq 0$

(iv) $S=C=S$ $\mu = 0$

143. Ans. (A)

(A) O - Dichlorobenzene (B) m - Dichlorobenzene (C) p - Dichlorobenzene

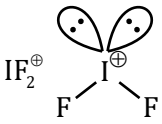
 $\mu \neq 0$ >  $\mu \neq 0$ >  $\mu = 0$

144. Ans. (B)

CO_2 is linear molecule while H_2O is an angular molecule.

145. Ans. (C)

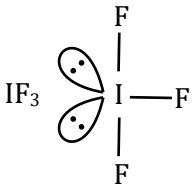
(A) x = 2 and n = +1



sp^3 hybridization, polar

bent shape, planar

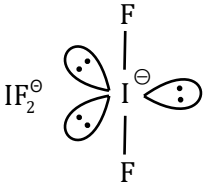
(B) x = 3 and n = 0



sp^3d hybridization, polar

T shape, planar

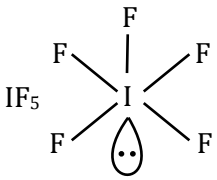
(C) x = 2 and n = –1



sp^3d hybridization, non-polar

Linear shape, planar

(D) x = 5 and n = 0



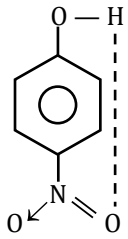
sp^3d^2 hybridization, non-polar

Sq. pyramidal, non-planar

146. Ans. (D)

BF_3 is planar while NF_3 is pyramidal due to the presence of lone pair of electron on nitrogen in NF_3.

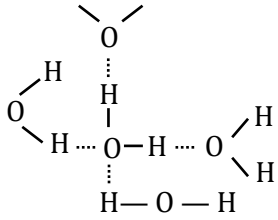
147. Ans. (C)



Shown Hydrogen bond is not possible as NO_2 is present at 'para' position.

148. Ans. (A)

$H_2O \Rightarrow$ The oxygen has two l.p. which can be donated to form two other hydrogen bonds. So, a water molecule can form maximum four Hydrogen bonds.



149. Ans. (D)

Crystal lattice of ice formed by covalent as well as H - bond.

150. Ans. (C)

$KHF_2 \rightarrow K^{\oplus} + [HF_2]^{\ominus}$

151. Ans. (B)

Stronger intermolecular forces would make the substance less volatile.

Intermolecular H - bonding in p-nitrophenol So p-nitrophenol is less volatile.

152. Ans. (B)

In 'H_2S', Sulphur is not much electronegative as oxygen so that hydrogen sulphide is not as polar as water.

153. Ans. (B)

Order of volatility

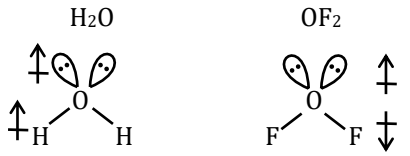
HCl > HBr >HI > HF

Volatility depend upon intermolecular forces as molecular weight increases so Vander waal's force increases and volatility decreases and HF is least volatile.

154. Ans. (D)

More Stronger intermolecular H - bonding increases the boiling point.

155. Ans. (C)



In H_2O, the direction of lone pair dipole moment and bond dipole moment is in the same direction. Hence H_2O has more dipole moment.

156. Ans. (C)

Ethanol $\Rightarrow C_2H_5OH$

Dimethyl ether $\Rightarrow CH_3OCH_3$

Ethanol shows inter molecular hydrogen bonding but Dimethyl ether shows only weak intermolecular forces so because of hydrogen bonding ethanol has a higher boiling point than dimethyl ether though they have the same molecular weight.

157. Ans. (C)

HF

Hydrogen attached to strong EN atom(F)

So, shows H-bond

CH_3OH

Hydrogen attached to strong EN atom(O)

So, shows H-bond

N_2O_4

No H atom, So no HBond

CH_4

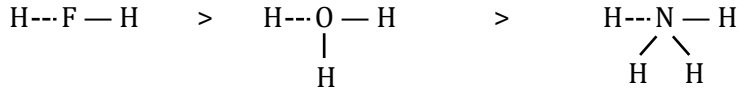
Hydrogen not attached to any strong EN atom

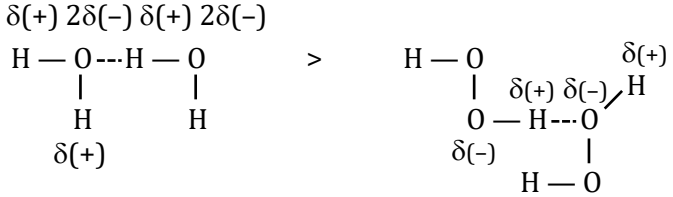
So, no H-bond

So, HF, CH_3OH would have significant intermolecular hydrogen bonding.

158. Ans. (C)

The strength of hydrogen bonding depends on the polarity of H-A which further depends upon the difference in the electronegativity of H and A atoms.



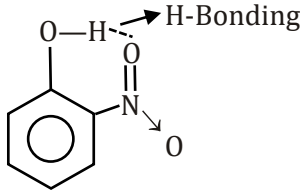


The accumulated negative charge on oxygen atom in H_20 is more as compared to that in H_2O_2.

So, strength of hydrogen bonding in H_2O is more than H_2O_2.
No hydrogen bonding in H_2S.
So correct order is (C) HF > H_2O > H_2O_2 > H_2S

159. Ans. (B)

o-nitro phenol shows intra molecular hydrogen bonding.

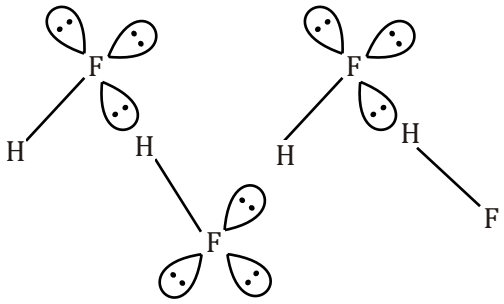


Ortho Nitro - phenol

160. Ans. (B)

The strength of hydrogen bonding depends on the polarity of H-A which further depends upon the difference in the electronegativity of H and A atoms.
EN of F > O > N. So, HF have stronger H bonding than H_2O and H_2O have stronger H-Bonding than NH_3.

161. Ans. (C)



Hydrogen Bonding
In this arrangement distance between two fluorine atoms are maximum so the repulsion will be the minimum and structure is most stable.

162. Ans. (B)

H – F has highest boiling point because it has hydrogen bonding.

163. Ans. (D)

Only NH_3 forms H-bonds.

164. Ans. (B)

Acetic acid exists as dimer in benzene due to inter molecular hydrogen bonding.

165. Ans. (A)

Water is dense than ice because of hydrogen bonding interaction and structure of ice.

166. Ans. (A)

Debye force is a weakest force and it is caused by interaction of permanent dipoles with dipole induced by them in $e^{\ominus}$ clouds.

167. Ans. (B)

Ion-induced dipole interaction : $(r^{4\ominus})$ or $\left(\frac{1}{r^4}\right)$

168. Ans. (A)

Iodine molecules are held in solid lattice by london dispersion force.

169. Ans. (A)

Kr gas will liquefies easily among the given gases because it can be polarised easily due to large size.

170. Ans. (D)

Interionic intermolecular forces depend on the charge of species and ions are charged species whereas dipole is partial charged.

171. Ans. (D)

As the molecular weight and surface area increases boiling point increases.

Order of boiling point : $He < D_2 < T_2$

172. Ans. (A)

Correct order of the boiling point : $B(OH)_3 > B(OCH_3)_3$

173. Ans. (A)

Because Br_2 is a non polar molecule.

174. Ans. (B)

(A) Boiling point NMe_3 is greater than NF_3 because NMe_3 is bulky molecule with lighter molecular mass. So greater energy required to break this bond.

(B) Larger dipole moment greater dipole - dipole Attraction.

(C) LDF increases with increases of no. of $e^{\ominus}$.

(D) Boiling point of Hydride of carbon increases down the group.

175. Ans. (C)

The melting and boiling points of argon is low hence, in solid argon atoms are held together by weak Vander Waal's forces.

176. Ans. (D)

Ice has weakest bond as it contains hydrogen bond.

177. Ans. (A)

Generally, zero group elements are linked by the Vander Waal's force. Hence these show weakest intermolecular forces.

178. Ans. (C)

Vander waal's forces is the weakest force of attraction.

179. Ans. (B)

(1) London force, $E \propto \frac{1}{r^6}$

(2) Hydrogen bond, $E \propto \frac{1}{r^3}$ (Dipole-Dipole interaction)

(3) Ion-ion interaction, $E \propto \frac{1}{r}$

(4) Ion-dipole interaction, $E \propto \frac{1}{r^2}$

180. Ans. (B)

As mass increases, boiling point also increases.

181. Ans. (A)

Increases in melting point of noble gases as its atomic mass increases due to the instantaneous dipole induced dipole attraction.

182. Ans. (D)

CCl_4 has more boiling point than $SiCl_4$ due to the comparatively Hight electronegativity difference between Si and Cl than C and Cl.

183. Ans. (B)


, Because all valence electrons are paired.

184. Ans. (A)

Bonding molecular orbital is formed by positive overlap of atomic orbitals.

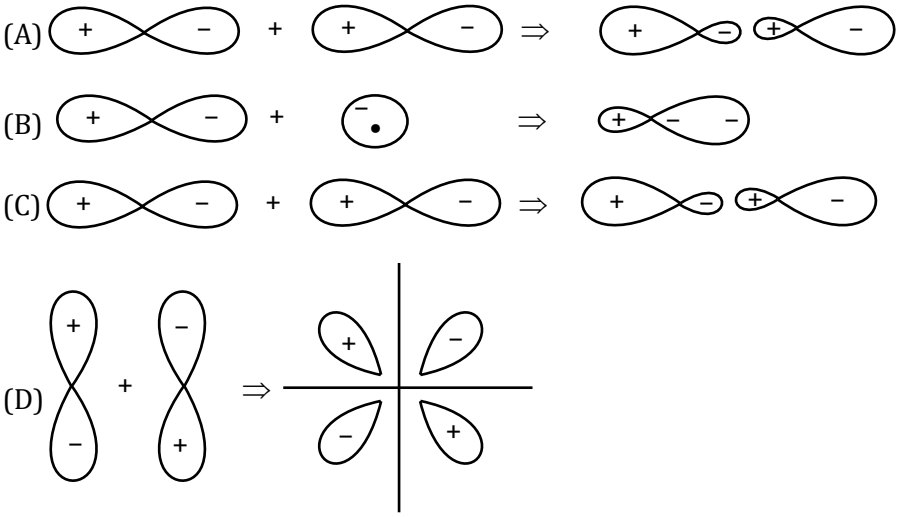
185. Ans. (A)

Number of atomic orbitals getting intermixed is equal to the number of molecular orbitals obtained.

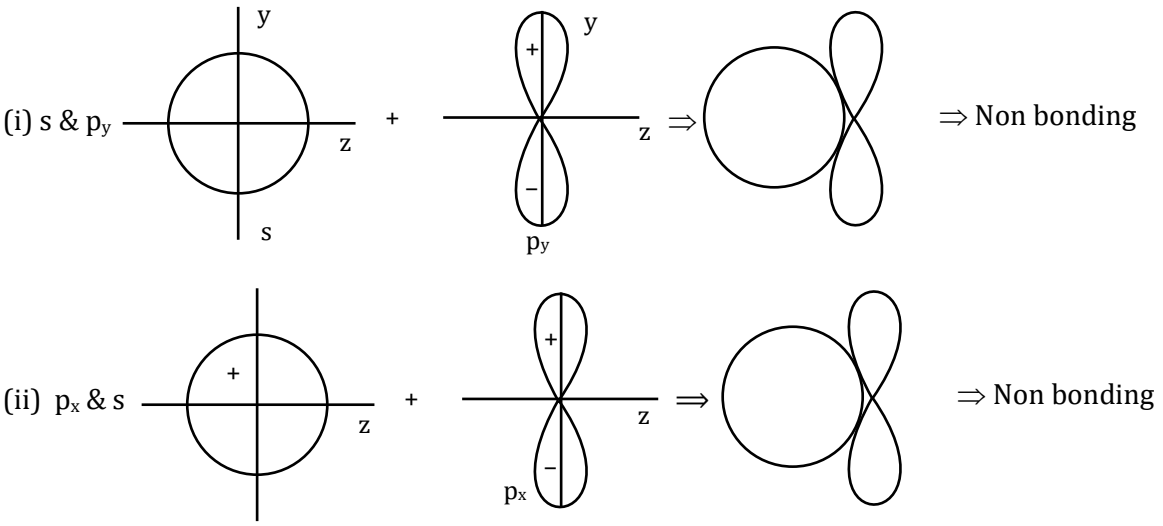
186. Ans. (C)

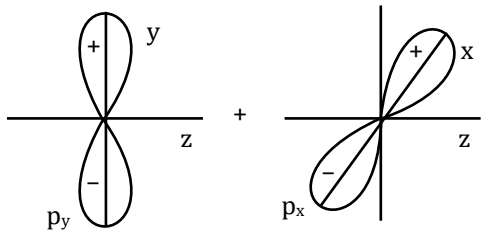
He_2 has zero bond order.

187. Ans. (C)



188. Ans. (D)



(iii) p_x & p_y 

$\Rightarrow$ Non bonding

189. Ans. (A)

$O_2^{\ominus}$	and	$O_2^{2\ominus}$
$\Downarrow$		$\Downarrow$
Unpaired $e^{\ominus}$		Paired $e^{\ominus}$
Paramagnetic (super oxide)		diamagnetic (per oxide)

190. Ans. (A)

The antibonding electron in He–H molecule decreases the bond order and there by the stability.

191. Ans. (A)

$KO_2 = 1 + 6\,(2) = 13e^{\ominus}$

192. Ans. (B)

$NO_2^{\oplus} > NO_2^{\ominus} \Rightarrow$ B.O. = 2.5

B.O of both $NO_2^{\oplus}$ and $NO_2^{\ominus}$ is 2.5 but $NO_2^{\ominus}$ has more antibonding $e^{\ominus}$ which leads to unstability.

193. Ans. (A)

$N_2 \Rightarrow \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \left(\pi_{2px}^2 = \pi_{2py}^2\right)\ \sigma_{2pz}^2$

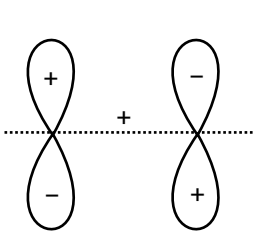
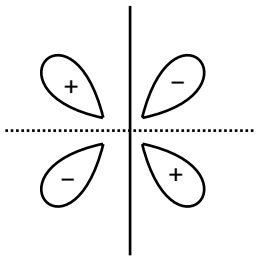
$N_2^{\oplus} \Rightarrow \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \left(\pi_{2px}^2 = \pi_{2py}^2\right)\ \sigma_{2pz}^1$

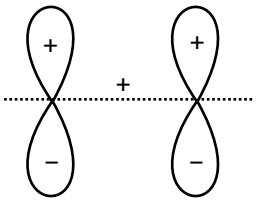
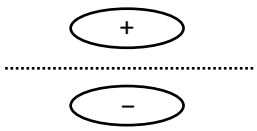
$1e^{\ominus}$ removed from σ orbital.

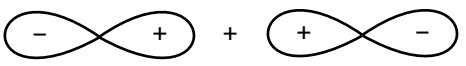
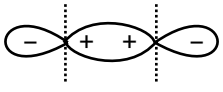
194. Ans. (C)

Nodal plane is a plane in which probability of electron density is zero.

195. Ans. (C)

(A)  $\Rightarrow$  $\Rightarrow$ Gerade symmetry

(B)  $\Rightarrow$  $\Rightarrow$ Ungerade

(C)  $\Rightarrow$  $\Rightarrow$ Gerade symmetry

196. Ans. (C)

B.O. of O_2 is 2,

B.O. of $O_2^{1\ominus}$ is 1.5,

B.O. of $O_2^{1\oplus}$ is 2.5

B.O. of $O_2^{2\ominus}$ is 1.

197. Ans. (C)

$O_2^{\ominus}(2\times8+1=17)$ has odd number of electrons and hence it is paramagnetic. All the remaining molecules/ions, *i.e.*,

$CN^{\ominus}(6+7+1=14)$ diamagnetic

$NO(7+8=15)$ has odd number of electrons and hence it is paramagnetic.

198. Ans. (C)

$H_2^{\ominus}: (\sigma_{1s})^2(\sigma^*_{1s})^1$

199. Ans. (C)

The paramagnetic nature of oxygen molecule is best explained on the basis of molecular orbital theory.

200. Ans. (B)

	$He_2^{\oplus}$	H_2	$H_2^{\oplus}$	$H_2^{\ominus}$
$\overset{*}{\sigma}(1s)$	$\uparrow$			$\uparrow$
$\sigma(1s)$	$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow$	$\uparrow\downarrow$
B.O.	$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$
Magnetic nature	P	D	P	P

(*P* = Paramagnetic, *D* = Diamagnetic)

201. Ans. (C)

π^*_{2py} has two nodal planes

202. Ans. (B)

$$\text{Bond Order} \propto \frac{1}{\text{Bond Length}}$$

Bond order of $O_2^{\oplus}$ is highest

203. Ans. (C)

	N_2	$\rightarrow$	$NO_2^{\oplus}$
Bond order	$\Rightarrow$ 3		2.5
Bond length	$\Rightarrow$ $N_2 < NO_2^{\oplus}$		

Bond length in $NO_2^{\oplus}$ is higher than N_2.

204. Ans. (A)

$$\text{Bond Order}(\uparrow) \propto \text{Bond Energy}(\uparrow)\ \text{B.E.} \propto \frac{1}{(\text{Bond Length})(\downarrow)}$$

205. Ans. (B)

	$N_2^{\oplus}$	$O_2^{\oplus}$	NO
	$13e^{\ominus}$	$15e^{\ominus}$	$15e^{\ominus}$
Bond order →	2.5	2.5	2.5

206. Ans. (D)

		Bond order
N_2	→	3
$N_2^{\ominus}$	→	2.5
$N_2^{\oplus}$	→	2.5
$N_2^{2\ominus}$	→	2

Bond order $\propto$ Bond Energy

207. Ans. (A)

$N_2 \rightarrow N_2^{\oplus}$

Bond order $\Rightarrow$ 3 2.5Bond Length $\uparrow$

$O_2 \rightarrow O_2^{\oplus}$

Bond order $\Rightarrow$ 2 2.5Bond Length $\downarrow$

208. Ans. (B)

Last $e^{\ominus}$ in F_2 is being removed from ABMO.

209. Ans. (B)

Last $e^{\ominus}$ in O_2 is being removed from ABMO.

210. Ans. (A)

$N_2 : \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\left[\pi_{2px}^2 = \pi_{2py}^2\right]\sigma_{2pz}^2\left[\pi_{2px}^{*} = \pi_{2py}^{*}\right]$

Lowest unoccupied molecular orbital (LUMO) Can be π_{2px}^{*} or π_{2py}^{*}

211. Ans. (A)

$O_2 : \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2pz}^2\left[\pi_{2px}^2 = \pi_{2py}^2\right]\left[\pi_{2px}^{*1} = \pi_{2py}^{*1}\right]$

212. Ans. (A)

Higher the bond order, higher will be the stability.

213. Ans. (C)

$B_2^{1\oplus}$ has lowest bond order 0.5, hence it has highest bond length.

214. Ans. (C)

$HeH^{\oplus}$ (total $\bar{e}$ = 2) σ_{1s}^2

Bond order = $\frac{1}{2}(N_b - N_a)$

$= \frac{1}{2}(2-0) \Rightarrow 1$

$He_2^{\oplus}$ (total $\bar{e}$ = 3)

$\sigma_{1s}^2, \sigma_{1s}^{*1}$

B.O = $\frac{1}{2} = 0.5$

Bond energy $\propto$ bond order

Thus, bond energy of $HeH^{\oplus}$ > $He_2^{\oplus}$

215. Ans. (B)

OF total electrons = 17

$\sigma_{1s}^2, \sigma^{*2}_{2s}, \sigma_{2s}^2, \sigma^{*2}_{2s}, \sigma_{2pz}^2, \pi_{2px}^2 = \pi_{2py}^2, \pi^{*2}_{2px} = \pi^{*1}_{2py}$

Bond order = $\frac{1}{2}$ $(N_b - N_a)$

B.O = $\frac{1}{2}$ $(10 - 7)$

= 1.5 Thus correct option is (B)

216. Ans. (A)

For N_2 molecule, total electrons = 14

$\left(\sigma_{1s}\right)^2\left(\sigma^*_{1s}\right)^2\left(\sigma_{2s}\right)^2\left(\sigma^*_{2s}\right)^2\left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\sigma_{2pz}\right)^2\left(\pi^*_{2px} = \pi^*_{2py}\right)\left(\sigma^*_{2pz}\right)$

Here four ABMO electrons present

217. Ans. (D)

The hydration of ionic compounds involves evolution of heat, weakening of attractive forces, dissociation into ions.

218. Ans. (C)

Hydration energy $\propto \frac{q}{r}$

$\frac{q}{r}$ is smaller for $Na^{\oplus}$ than $Mg^{2\oplus}$

So, $Mg^{2\oplus}$ has greater hydration energy than $Na^{\oplus}$.

219. Ans. (D)

AgI is least soluble in water due to very small hydration energy.

220. Ans. (D)

Ionic conductance $\propto$ ionic mobility $\propto \frac{1}{(\text{effective size of ions})}$

Effective size order : $Li^{\oplus}$ (aq) > $Na^{\oplus}$ (aq > $K^{\oplus}$ (aq) > $Rb^{\oplus}$ (aq) > $Cs^{\oplus}$ (aq)

So, ionic conductance order : $Li^{\oplus}$ (aq) < $Na^{\oplus}$ (aq) < $K^{\oplus}$ (aq) < $Rb^{\oplus}$ (aq) < $Cs^{\oplus}$ (aq)

221. Ans. (D)

Ionic mobility $\propto \frac{1}{(\text{effective size of ions})}$

effective size order : $Li^{\oplus}$ (aq) > $Na^{\oplus}$ (aq) > $K^{\oplus}$ (aq) > $Rb^{\oplus}$ (aq)

So, $Rb^{\oplus}$ (aq) has maximum ionic mobility.

222. Ans. (B)

Compound will be soluble in water, when

Lattice energy < Hydration energy

and will be sparingly soluble or insoluble if

Lattice energy > Hydration energy

Hence, for Na_2SO_4 Hydration energy > Lattice energy, whereas for $BaSO_4$,

Lattice energy > Hydration energy

223. Ans. (B)

The more soluble compound in each pair is :

(a) $BeSO_4 > BaSO_4$

(b) LiOH < (CsOH)

(c) Ag Cl > AgI

$\Rightarrow$ (B) $BeSO_4$, CsOH, AgCl

224. Ans. (D)

Electrical conductivity in aq. Medium depend on the size of cation (hydrated size) when cation is small in gas phase then, positive charge density of such cation will be high and this cation will easily attract the more number of water molecules. Due to which hydrated size of cation will be large when hydrated size of cation is large then such cation will have lesser electrical conductance in aq. Medium because ionic mobility of large cation (large hydrated radius) will be less.

$Li^{\oplus}(aq.) > Na^{\oplus}(aq.) > k^{\oplus}(aq.) > Rb^{\oplus}(aq.) > Cs^{\oplus}(aq.)$ (Hydrated size)

Electrical conductance $Li^{\oplus}(aq.) < Na^{\oplus}(aq.)\ k^{\oplus}(aq.) <$ Rb (aq.) + < Cs + (aq.)

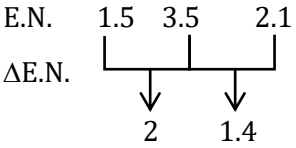
225. Ans. (C)

$Al(OH)_3$ is amphoteric hydroxide because it react with acid and base both

$Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$

$Al(OH)_3 + NaOH \rightarrow Na[Al(OH)_4]$

In Al – O – H bond, Al – O bond can be broken more easily as compare to O-H bond as ΔEN in Al-O bond is more as compare to O-H bond.



More polar bond is easily broken in H_2O (polar solvent).

226. Ans. (A)

$$\text{Hydrated radius} \propto = \frac{\text{Charge}}{\text{size}}$$

227. Ans. (B)

Small size cation has high polarising power hence, greater covalent character will be observed.

Be is Small size cation (Covalent character increases).

Rb is large size cation (ionic character increases).

228. Ans. (B)

According to Fajan's Rule, compound with maximum ionic character is formed from Cs and F.

229. Ans. (B)

Out of the given cation $Be^{2\oplus}$ is the smallest size cation and $K^{\oplus}$ is the large size cation.

230. Ans. (A)

There is more polarization of Cl in CCl_4.

231. Ans. (B)

Tendency to form covalent bond in a group decreases due to increase in size.

232. Ans. (B)

(A) $BeCO_3 < BaCO_3$ (covalent character) order is incorrect covalent character $\propto \frac{1}{\text{size of cation}}$

Correct covalent order is $BeCO_3 > BaCO_3$

(B) BeO > SrO (lattice energy) L.E. $\propto \frac{1}{\text{inter ionic distance}}$

As size of cation ↑, inter ionic distance ↑and L.E.↓.

(C) $Be^2 + 7Li^{\oplus}$ (H.E.) hydration energy $\frac{1}{\text{size of cation}}$

Hydration energy $\propto \frac{1}{\text{size of cation}}$

(D) $Li^{\oplus}$ (aq.) > $Be^{2\oplus}$(aq.) : Ionic mobility

Ionic mobility $\propto \frac{1}{\text{Hydrated size}}$

233. Ans. (A)

When ionic substance are dissolved then following there process are performed –
(a) weaking of ionic bonds (b) attraction of ions towards solvent molecules (c) solvation of ions when solvent ismost polar then it's dielectric constant will be high and such solvent will break ionic solid easily. Thus, dipole moment of solvent must be higher when ionic solid is more attracted towards solvent then ionic interaction will be broken with ease.
High solvation of ions will release more solvation energy which will enhances of dissolution of ionic solid in the given solvent.

234. Ans. (B)

$AlCl_3$ is a lewis acid due to incomplete actet of aluminium. When anhydrous AlCl3 is dissolved in diethyl ether then $AlCl_3$ is hydrated then $AlCl_3$ already accept the lone pair from the water so now hydrated $AlCl_3$ will not accept lone pair from the diethyl ether.
Thus, solubility of anhydrous $AlCl_3$ will be high.
$S_1 > S_2$.

235. Ans. (D)

$BaCl_2$ contain higher ionic character.

236. Ans. (B)

Ionic compounds have high lattice energy.

237. Ans. (D)

Covalent character depends on the size of cation and anion.

238. Ans. (A)

According to Fajan's rule, polarisation of anion is influenced by charge and size of cation, more is the charge on cation, more is polarisation of anion.

239. Ans. (C)

HCl is most polar due to high electronegativity of Cl.

240. Ans. (D)

p-dichloro benzene have highest melting point due to high packing efficiency and mass.

241. Ans. (B)

Greater the charge of cation more will be its polarising power (according to Fajan's rule).

242. Ans. (D)

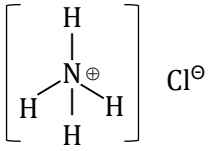
AlI_3 Aluminiumtriiodide shows covalent character. According to Fajan's rule.

243. Ans. (C)

According to fajan's rule, convalent bond is favoured by small cation and large anion.

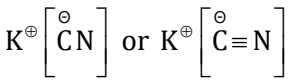
244. Ans. (A,C)

(A) NH_4Cl contains (ionic, covalent and coordinate bond)



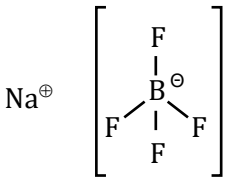
ionic bond

(B) KCN Contain (ionic and covalent bond)



Ionic bond

(C) $NaBF_4$ Contain (ionic, covalent and coordinate bond)



Ionic bond

(D) NaOH Contain (ionic and covalent bond)

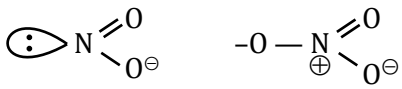
Ionic bond

245. Ans. (B,C)

(A)

	$^{\ominus}C \equiv O^{\oplus}$		$O = C = O$
B.O.	3	>	2
B.L.(C-O)	CO	<	CO_2

(C)



B.O.	$\frac{3}{2}$	>	$\frac{4}{3}$
B.L. (N-O)	$NO_2^{\ominus}$	<	$NO_3^{\ominus}$

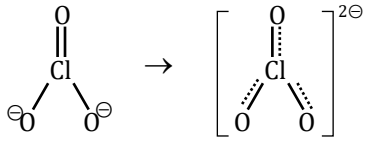
246. Ans. (A, C)

(A) In hybridization atomic orbitals of same or nearly same energy level intermix with each other

(C) 90 and 180° angles are formed in sp^3d^2 hybridization.

247. Ans. (B,C,D)

(bcd) It has all the characteristics.



- Bonds are of equal length.
- Carbon is sp^2 hybridised.
- Resonance is possible.
- Same bond angles.

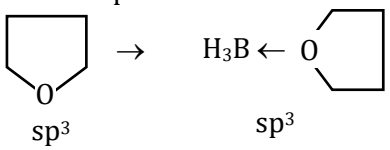
248. Ans. (A, C)

(A) $NH_3 + BF_3 \rightarrow H_3N.BF_3$ → No change

sp^3 sp^3

(B) $SiF_4 + 2F^{\ominus} \rightarrow [SiF_6]^{2\ominus}$ → Change in hybridisation

sp^3 sp^3d^2

(C) BH_3 +  → No change

sp^3 sp^3

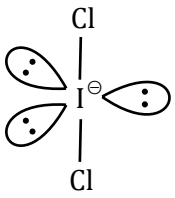
(D) $H_3\underline{B}O_3 + \overset{\ominus}{O}H \rightarrow [\underline{B}(OH)_4]^{\ominus}$ → Change in hybridisation

sp^3 sp^3

249. Ans. (A, B, C)

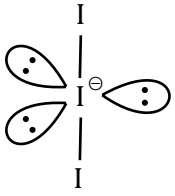
(A) $ICl_2^{\ominus}$

sp^3d hybridization Linear shape



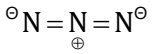
(B) $I_3^{\ominus}$

sp^3d hybridization Linear shape



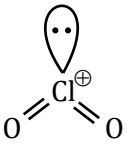
(C) $N_3^{\ominus}$

sp hybridization Linear shape



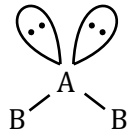
(D) $ClO_2^{\oplus}$

sp^2 hybridization Bent shape



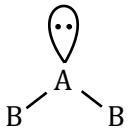
250. Ans. (A, B)

(A) AB_2E_2



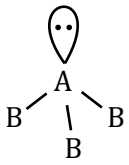
sp^3 hybridization, bent shape due to presence of two lone pairs

(B) AB_2E



sp^2 hybridization, bent shape due to presence of lone pair

(C) AB_3E



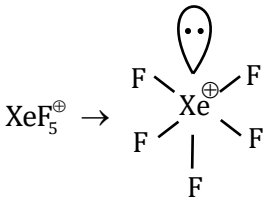
sp^3 hybridization, pyramidal shape due to presence of lone pair

(D) AB_2

B — A — B sp hybridization, linear shape

251. Ans. (B, C)

in solid state XeF_6 exist as $XeF_5^{\oplus}$ and $F^{\ominus}$



sp^3d^2 hybridization,

d_{z^2} and $d_{x^2-y^2}$ orbitals are involved in sp^3d^2 hybridization.

252. Ans. (C,D)

Incorrect order

(A) $OCl_2 > SF_2 \rightarrow$ correct

(B) $H_2O > OF_2 \rightarrow$ correct

(C) $SO_4^{2\ominus} > CF_4 \rightarrow$ incorrect $\rightarrow$ because equal bond angle

(D) $NF_3 > NH_3 \rightarrow$ incorrect, as $NH_3 > NF_3$

253. Ans. (B, C)

Correct statements :

(A) Incorrect $\rightarrow$ because bond angle of CF_4 and CH_4 are equal

(B) Correct $\rightarrow d_{N-O}$ in $NO_2^{\ominus} < d_{N-O}$ in $NO_3^{\ominus}$ because in $NO_2^{\ominus} \rightarrow$ bond order = 1.5

Bond order $\propto 1/$(Bond length)

$NO_3^{\ominus} \rightarrow$ bond order = 1.33

(C) correct $\rightarrow$ B.O. of $SO_3^{2\ominus} \rightarrow 1.33$

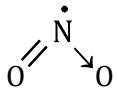
$\rightarrow$ B.O. of $SO_4^{2\ominus} \rightarrow 1.5$

(D) Incorrect $\rightarrow$ because bond angle of $NH_3 > PH_3$

254. Ans. (A,B,D)

Due to Drago's rule, hybridisation is not possible in these molecules.

255. Ans. (A,B,C)



$BO = \frac{3}{2} = 1.5$

So, correct options is A,B,C.

256. Ans. (B,C,D)

(A) $\dot{C}H_3 \rightarrow sp^2 \rightarrow$ Trigonal planar (planar)

(B) $\dot{C}F_3 \rightarrow sp^3 \rightarrow$ non planar

(C) $CHF_3 \rightarrow sp^3 \rightarrow$ Tetrahedral (non planar)

(D) $CH_2F_2 \rightarrow sp^3 \rightarrow$ Tetrahedral (non planar)

So, correct option is B,C,D.

257. Ans. (C, D)

NCl_5 and OF_4 does not exist because 'N' and 'O' belongs to second period and they are not capable of expanding their octet.

258. Ans. (A, B, C)

(A) SH_6 does not exist because 'H' atom is not capable of contracting 'd' orbital of Sulphur due to less EN

(B) HFO_4 does not exist because fluorine is not capable of expanding its octet

(C) $SiCl_6^{2\ominus}$ does not exist due to crowding factor

259. Ans. (A, C, D)

IH_3 does not exist because 'H' is not capable of contracting 'd' orbital of iodine atom due to less EN.

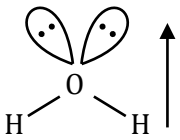
260. Ans. (B, D)

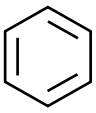
$\Rightarrow$ SH_4 and XeH_4 does not exist because 'H' atom is not capable of contracting 'd' orbital of Sulphur and Xe atom respectively due to less EN.

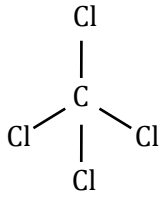
$\Rightarrow$ OF_4 does not exist because oxygen does not have vacant d- orbital.

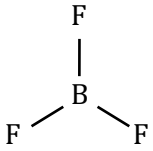
$\Rightarrow$ $PBr_6^{\ominus}$ does not exist due to crowding factor.

261. Ans. (B, C, D)

(A)Water  $\mu \neq 0$

(B) Benzene  $\mu = 0$

(C) Carbon tetrachloride  $\mu = 0$

(D) Boron trifluoride  $\mu = 0$

262. Ans. (A,B)

(A) Covalent bond are directional because they formed by overlapping in proper direction.

(B) Ionic bond is formed by electrostatic force of attraction which is non directional.

(C) If two atoms are having same electronegativity then non polar bond is formed.

(D) If polar bond is present then net dipole moment may or may not be zero.

263. Ans. (A,B,C)

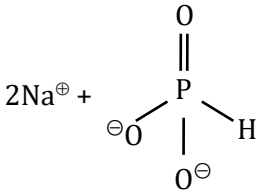
The density of water increases from 0°C to 4°C.

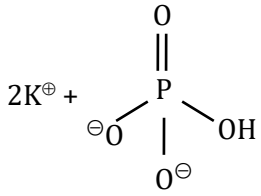
264. Ans. (A,B,C,D)

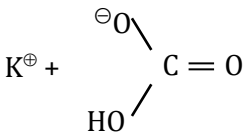
H_2O has more H-bonding as compare to CH_3OH, NH_3 and HF so boiling point is higher.

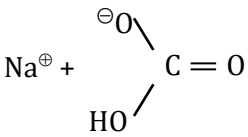
H - bonding increases the boiling point.

265. Ans. (B, C, D)

(A)$Na_2HPO_3(s)$ 

(B) $K_2HPO_4(s)$ 

(C) $KHCO_3(s)$ 

(D) $NaHCO_3(s)$ 

Hydrogen bond is formed when hydrogen is covalently bonded to more EN atom like F, O, N.

In (A) OPTION 'H' is covalently bonded to phosphorous so hydrogen bond is not formed.

266. Ans. (A,B,C)

Due to the weak forces of attraction.

267. Ans. (A,B,C)

In diamond, covalent bond exists between two carbon atoms.

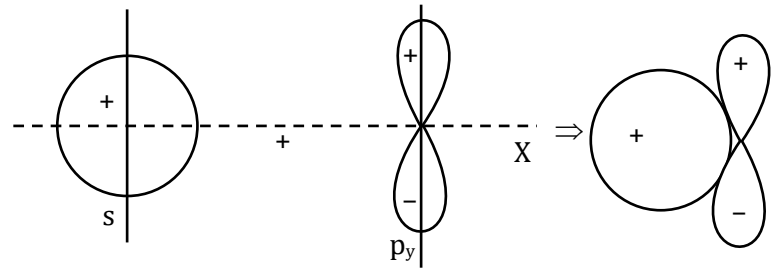
268. Ans. (A,B,C)

London forces depends upon

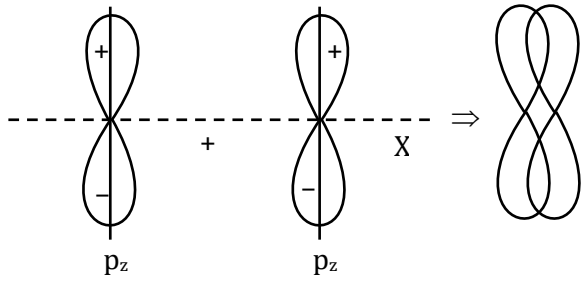
1. Molecular weight
2. Number of polarisable electrons
3. Molecular size

269. Ans. (A,C,D)

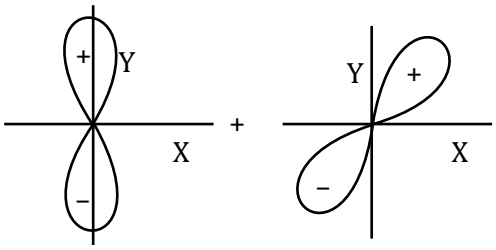
If intermolecular axis is x - axis.

(A) s & $p_y \Rightarrow$ 

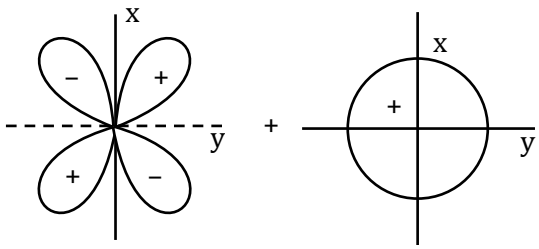
Non bonding M.O.

(B) p_z & $p_z \Rightarrow$ 

Bonding M.O.

(C) p_y & $p_z \Rightarrow$ 

⇒ Non bonding M.O.

(D) d_{xy} & s $\Rightarrow$ 

⇒ Non bonding M.O.

270. Ans. (B,D)

$N_2 \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu = 0$ non-polar

$CO \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu \neq 0$ polar

$CN^- \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu \neq 0$ polar

$NO^+ \Rightarrow$ BO = 3, $14e^{\ominus}$ Diamagnetic $\mu \neq 0$ polar

For homo nuclear diatomic molecule electron should be filled in the order

$$\sigma_{1s}\ \sigma^*_{1s}\sigma_{2s}\ \sigma^*_{2s}\ \left(\pi_{2px}=\pi_{2py}\right)\sigma_{2pz}\ \left(\pi^*_{2px}=\pi^*_{2py}\right)\sigma^*_{2pz}$$

For electrons = 14

$$\sigma^2_{1s}\ \ \sigma^{*2}_{1s}\ \ \sigma^2_{2s}\ \ \sigma^{*2}_{2s}\ \ \left(\pi^2_{2px}=\pi^2_{2py}\right)\ \sigma^2_{2pz}$$

Correct option is B and D.

271. Ans. (A,B,C,D)

$\sigma_{1s}\ \sigma^{*}_{1s}\sigma_{2s}\ \sigma^{*}_{2s}\ \sigma_{2pz}\ \pi_{2px} = \pi^{*}_{2py}\ \pi^{*2}_{2px} = \pi^{*}_{wpy}\ \sigma^{*}_{2pz}$

(A) $O_2^{\oplus} \Rightarrow \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*1}_{2px} = \pi^{*}_{2py}\right)$

(B) $O_2^{\ominus} \Rightarrow \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*2}_{2px} = \pi^{*1}_{2py}\right)$

(C) NO $\Rightarrow \sigma^2_{1s}\ \sigma^{*2}_{1s}\ \sigma^2_{2s}\ \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\ \sigma^2_{2pz}\left(\pi^{*1}_{2px} = \pi^{*}_{2py}\right)$

(D) $H_2^{\oplus} \Rightarrow \sigma\ 1s^1$

So, correct option is A,B,C,D.

272. Ans. (A,B)

$B_2: \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}\ \left(\pi^1_{2px} = \pi^1_{2py}\right)$

$O_2: \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*1}_{2px} = \pi^{*1}_{2py}\right)$

$N_2: \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\sigma^2_{2pz}$

$He_2: \sigma^2_{1s}, \sigma^{*2}_{1s}$

273. Ans. (A,B)

$N_2: \sigma^2_{1s}\ \sigma^{*2}_{1s}\ \sigma^2_{2s}\ \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\ \sigma^2_{2pz}$

$N_2^{\oplus} \Rightarrow \sigma^2_{1s}\ \sigma^{*2}_{1s}\ \sigma^2_{2s}\ \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\ \sigma^1_{2pz}$

$N_2^{\ominus} \Rightarrow \sigma^2_{1s}\ \sigma^{*2}_{1s}\ \sigma^2_{2s}\ \sigma^{*2}_{2s}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\ \sigma^2_{2pz}\left(\pi^{*1}_{2px} = \pi^{*}_{2py}\right)$

$O_2: \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*1}_{2px} = \pi^{*1}_{2py}\right)$

$O_2^{\oplus} \Rightarrow \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*1}_{2px} = \pi^{*}_{2py}\right)$

$O_2^{\ominus} \Rightarrow \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}\ \left(\pi^2_{2px} = \pi^2_{2py}\right)\left(\pi^{*2}_{2px} = \pi^{*1}_{2py}\right)$

So correct option is A,B

274. Ans. (A,B,C)

(A) $O_2^{2\oplus} \Rightarrow 3$

(B) $NO^{\oplus} \Rightarrow 3$

(C) $CN^{\ominus} \Rightarrow 3$

(D) $CN^{\oplus} \Rightarrow 2$

So, correct option is A,B,C.

275. Ans. (A,B,D)

Peroxide ion = $O_2^{2\ominus} \Rightarrow$ B.O. = 1

O_2 molecule $\Rightarrow$ B.O. = 2

$\text{B.O.} \propto \text{B.E.} \propto \dfrac{1}{\text{B.L.}}$

Correct option is A,B,D.

276. Ans. (A,B,C)

(A) CO = 3

(B) $CN^{\ominus}$ = 3

(C) $NO^{\oplus}$ = 3

(D) $O_2^{\oplus}$ = 2.5

So, correct option is A,B,C.

277. Ans. (A,D)

(A) Thermal stability order : $MgSO_4 < SrSO_4 < BaSO_4$

(B) Solubility in water : $BeC_2O_4 < BaC_2O_4 < CaC_2O_4$

(C) Melting point order : NaCl > KCl > LiCl

(D) Covalent character order : $BeF_2 > CaF_2 > SrF_2$

278. Ans. (B,C,D)

→ High melting and boiling point

→ non-directional nature

→ High solubility in polar solvent

→ Good conductors of electricity in molten state

279. Ans. (A,B,C)

(A) Covalent character ∝ charge on cation

(B) Melting point ∝ Lattice energy

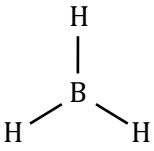
(C) Lattice energy $\propto \frac{\text{Charge on cation / anion}}{\text{radius on cation / anion}}$

280. Ans. (B)

The correct bond order

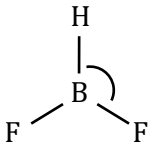
(A)$NH_3 > PH_3$ (Drago's Rule)

(B) $BF_3 = BH_3$



sp^2

Bond angle 120°

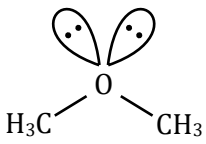


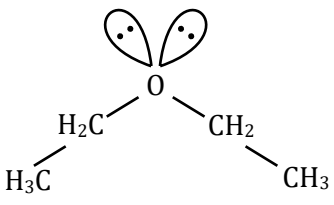
sp^2

Bond angle 120°

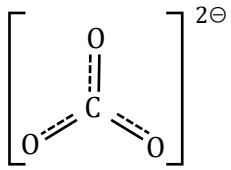
(C) $O(CH_3)_2 < O(C_2H_5)_2$

As size of alkyl group increases bond angle increases





(D) $CO_3^{2\ominus} < CO_2$

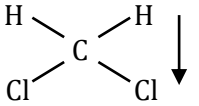
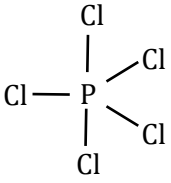
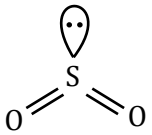
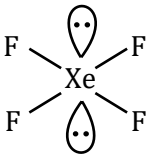


$O = C = O$

Bond angle 120°
sp^2

Bond angle 180°
sp

281. Ans. (A)

(A)CH_2Cl_2	(B) PCl_5	(C) SO_2	(D) XeF_4
			
$\mu \neq 0$ (polar)	$\mu = 0$ (non polar)	$\mu \neq 0$ (polar)	$\mu = 0$ (non polar)
Non planar sp^3 Tetrahedral	Non planar Trigonal bipyramidal	Planar V-Shape	Planar Square Planar

282. Ans. (A)

[A] $NO^{\ominus}$ Total number of electrons = 16 so, M.O. configuration is –

$$(\sigma_{1s})^2(\sigma^*_{1s})^2(\sigma_{2s})^2(\sigma^*_{2s})^2\ (\pi^2_{2px}=\pi^2_{2py})(\sigma_{2pz})^2(\pi^{*1}_{2px}=\pi^{*1}_{2py})$$

It contains two unpaired electrons so paramagnetic

[B] $O_2^{2\ominus} \Rightarrow$ Total $\bar{e}$ s = 18

$$Kk\ (\sigma_{2s})^2(\sigma^*_{2s})^2(\sigma_{2pz})^2\ (\pi^2_{2px}=\pi^2_{2py})(\pi^{*2}_{2px}=\pi^{*2}_{2py})$$

There is no unpaired electron so it is diamagnetic in nature

[C] $CN^{\ominus} \Rightarrow$ Total $\bar{e}$ s = 14

$$(\sigma_{1s})^2(\sigma^*_{1s})^2(\sigma_{2s})^2(\sigma^*_{2s})^2\ (\pi^2_{2px}=\pi^2_{2py})\ \sigma^2_{2pz}$$

All electrons are paired so diamagnetic

[D] $CO \Rightarrow$ Total $e^{\ominus}$ s = 14

Similarly, it has no unpaired electron in it's M.O. configuration so diamagnetic.

283. Ans. (D)

For Be_2 = $8\bar{e}$ (total)

M.O. configuration is $(\sigma_{1s})^2(\sigma^*_{1s})^2(\sigma_{2s})^2(\sigma^*_{2s})^2$

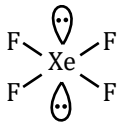
Hence,

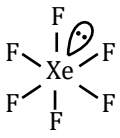
$$B.O = \frac{1}{2}[N_b - N_a]$$

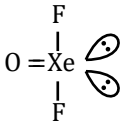
$$= \frac{1}{2}\ [4-4)$$

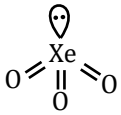
$$= 0$$

284. Ans. (A)

XeF_4  Square Planar

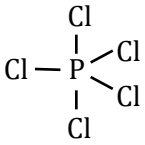
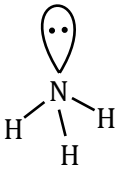
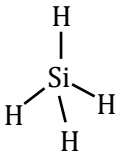
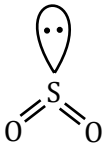
XeF_6  Distorted Octahedral

$XeOF_2$  T - Shape

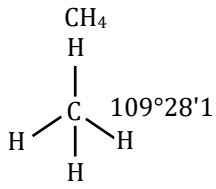
XeO_3  Trigonal Pyramidal

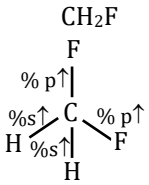
285. Ans. (B)

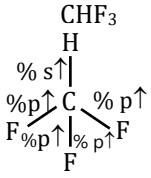
(A)Q,R,S; (B)Q,T; (C)R; (D)P,T

(A) PCl_5($\theta = 120°$), ($\theta = 90°$)	(B) NH_3($T = 107°$)	(C) SiH_4($T = 109° 28'$)	(D) SO_2($T = 116°$)
			
$\theta = 120°$ (3) $\theta = 90°$ (6) sp^3d	$\theta = 107°$ (3) Lone pair is present on N atom.	$\theta = 109°28'$(6)	$\theta = 116°$ (1) Lone pair is present on central atom
Q,R,S	Q,T	R	P,T

286. Ans. (C)

CH_4  Tetrahedral Shape

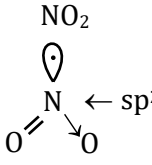
CH_2F  Max % p character B.A. Lowest

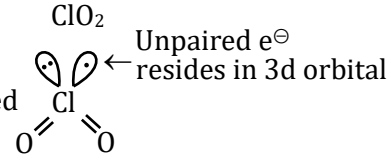
CHF_3  Max % s character

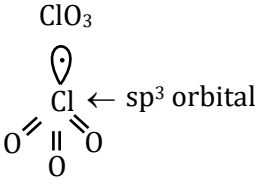
$CF_4 \rightarrow$ Same reason as CH_4

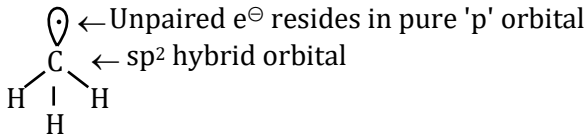
(A) $\rightarrow$ P,S, (B) $\rightarrow$ Q,T, (C) $\rightarrow$ R, (D) $\rightarrow$ P,S

287. Ans. (B)

NO_2  $\leftarrow sp^2$ hybridised

ClO_2  Unpaired $e^{\ominus}$ resides in 3d orbital

ClO_3  $\leftarrow sp^3$ orbital

 $\leftarrow$ Unpaired $e^{\ominus}$ resides in pure 'p' orbital

$\leftarrow sp^2$ hybrid orbital

288. Ans. (C)

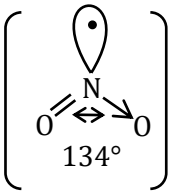
[P] $NO_2^{\oplus}$ Hybridisation $\Rightarrow$ sp

Geometry $\Rightarrow$ Linear $\left[O=\overset{\oplus}{N}=O\right]$

Bond angle $\Rightarrow$ 180°

[Q] NO_2 Odd electron species

Hybridisation $\Rightarrow$ sp^2

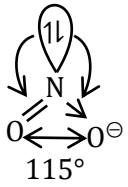


Geometry $\Rightarrow$ Angular

Bond angle $\Rightarrow$ 134°

[R] $NO_2^{\ominus}$ sp^2 hybridise

Angular



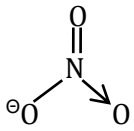
ℓ.p.–b.p repulsis

Due to presence of ℓ.p. B.A.

B.A = 115°

[S] $NO_3^{\ominus}$ nitrate ion

sp^2 hybridise

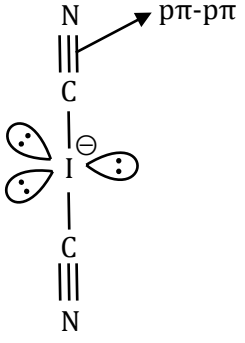
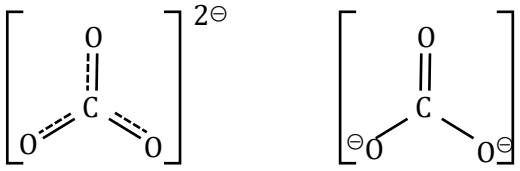


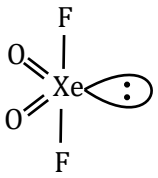
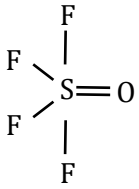
Trigonal planar

B.A = 120° due to resonance all bonds are equivalent

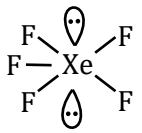
289. Ans. (C)

(A) P,R,S (B) P,R (C) Q,S (D) Q,S

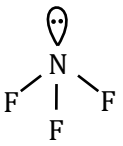
(A) $I(CN)_2^{\ominus}$	(B) $CO_3^{2\ominus}$
	

Linear(planar) sp^3d $\mu = 0$(non-polar)	Trigonal planar sp^2 π bond ($p\pi$-$p\pi$) $\mu = 0$(non-polar)
P, R, S	P, R
(C) XeO_2F_2	(D) SOF_4
	
See saw (non-planar) sp^3d π bond ($p\pi$-$d\pi$) $\mu \neq 0$ (polar)	Distorted TBP (non-planar) sp^3d π bond ($p\pi$ - $d\pi$) $\mu \neq 0$(polar)
Q,S	Q,S

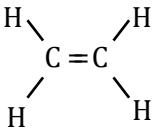
290. Ans. (B)



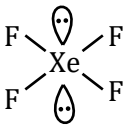
2 L.P on C.A
$\mu = 0$
planar
B.A. equal
(1) P, S;



B.A. equal
Non-planar
(2) P, R, S;



$\mu = 0$
Planar
B.A. $\neq$
Non-equal
(3) P, R, S;



2 l.P on C.A
$\mu = 0$
planar
B.A. equal
(4) P, Q, S

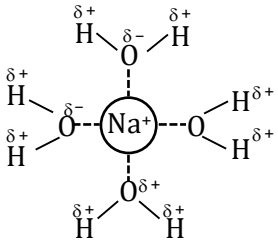
291. Ans. (C)

[P] Xe atom is nonpolar but ice molecutes are polar so operating interaction among them is dipole-Induced dipole.

[Q] London forces are responsible for the liquation of Xe gas or nonpolar gaseous molecules.

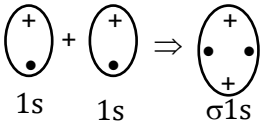
[R] HCl is polar molecule so dipole dipole interactions are involved for the liquation of HCl gas.

[S] hydration of $Na^{\oplus}$ Ion-dipole interactions are involved here.



292. Ans. (B)

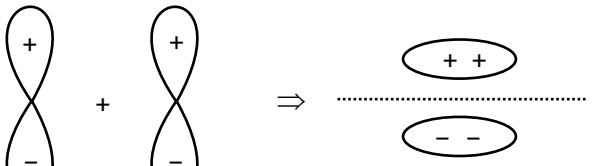
[A] (1) σ_{1s} B.M.O.



1s 1s σ1s

N.P=0
Gerade (ψ_g)
CO.S

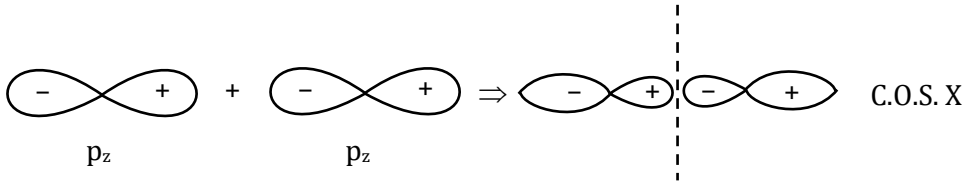
[B] (2) π_p B.M.O



Ungerade(Ψu)

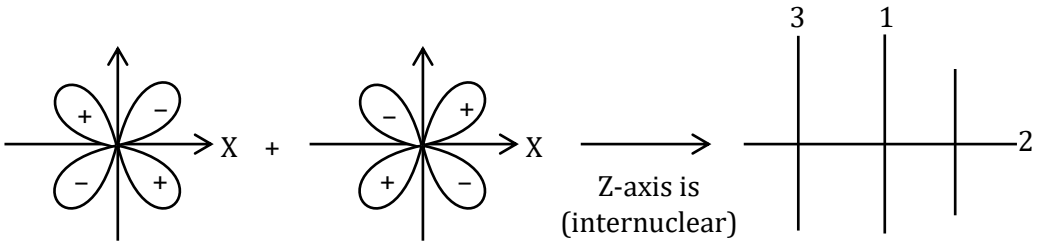
(Asymmetrical)

[C] (3) σ^*_{2pz} (A.B.M.O.)



Ungrade(Ψu)

[D] (3) δ* (ABMO) ⇒ ungerade



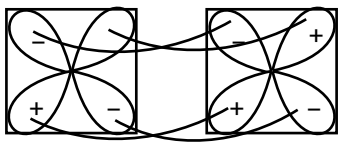
293. Ans. (C)

F_2 molecule ⇒ total $\bar{e}$s = 18

$$(\sigma_{1s})^2(\sigma^*_{1s})^2(\sigma_{2s})^2(\sigma^*_{2s})^2(\sigma^2_{2pz})(\pi^2_{2px}=\pi^2_{2py})(\pi^{*2}_{2px}=\pi^{*2}_{2py})\sigma^*_{2pz}$$

Here two σs 'molecular orbitals present

294. Ans. (D)



δ B.M.O.

N.P.=2(xz&yz)

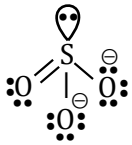
Gerade (Ψ_g)

EXERCISE - S

1. Ans. (0)

Number of directional bonds = 0 as ionic bonds are present in between $Na^{\oplus}$ and $Cl^{\ominus}$ ions and ionic bond is non directional.

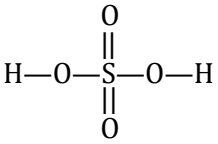
2. Ans. (13)



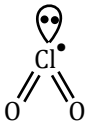
Bond Pair → 4
Lone pair → 9

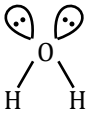
Total = 4 + 9 = 13

3. Ans. (4)

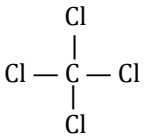
$H_2SO_4 \rightarrow$ actual structure  → exception to the octet rule

$BeCl_2 \rightarrow Cl - Be - Cl \rightarrow 4e^{\ominus} \rightarrow$ exception

$ClO_2 \rightarrow$  $\rightarrow 11e^{\ominus} \rightarrow$ exception

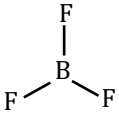
$H_2O \rightarrow$  → $8e^{\ominus}$ → not an exception

$H_2 \rightarrow$ H — H → complete duplet → not an exception

$CCl_4 \rightarrow$  → $8e^{\ominus}$ → not an exception

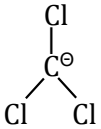
$HF \rightarrow$ H — F → not an exception

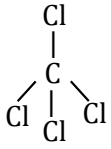
$NH_3 \rightarrow$  $\rightarrow 8e^{\ominus} \rightarrow$ not an exception

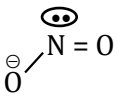
$BF_3 \rightarrow$  → $6e^{\ominus}$ → exception

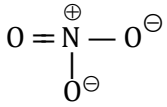
Total exception = 4

4. Ans. (5)

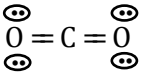
1. $CCl_3^{\ominus}$ 

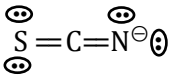
2. CCl_4 

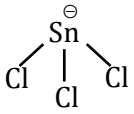
3. $NO_2^{\ominus}$ 

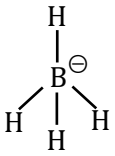
4. $NO_3^{\ominus}$ 

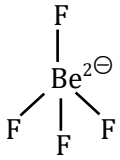
5. CO 

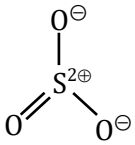
6. CO_2 

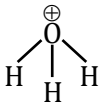
7. $SCN^{\ominus}$ 

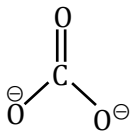
8. $SnCl_3^{\ominus}$ 

9. $BH_4^{\ominus}$ 

10. $BeF_4^{2\ominus}$ 

11. SO_3 

12. $H_3O^{\oplus}$ 

13. $CO_3^{2\ominus}$ 

5. Ans. (2)

$s + p_x$, $p_x + p_y$, $p_y + p_z$, $p_x + p_z$ cannot form any type of bond along y – axis.

6. Ans. (3)

Using 's' and 'p' orbitals maximum 3 bonds can be formed between two atoms i.e. (1σ, 2π).

7. Ans. (5)

$SF_4 \rightarrow sp^3d$

$POCl_3 \rightarrow sp^3$

$H_2O \rightarrow sp^3$

$XeO_3 \rightarrow sp^3$

$PCl_5 \rightarrow sp^3d$

$OF_2 \rightarrow sp^3$

$SO_3^{2\ominus} \rightarrow sp^3$

$XeO_3F_2 \rightarrow sp^3d$

$XeF_4 \rightarrow sp^3d^2$

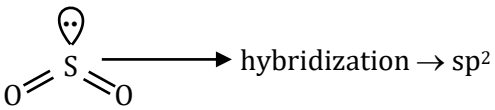
8. Ans. (0)

$IO_3^{\ominus}$

$2p\pi - 5p\pi = 0$

$2p\pi - 4d\pi = 2$

9. Ans. (1)



means π bonds are formed by 1 p - orbital and 1 - d orbitals of S. 'O' form π - bond by its p-orbitals

So, π - bonds are formed by pπ - dπ and pπ – pπ.

Hence, SO_2 has only (1) pπ - dπ bond.

10. **Ans. (3)**

Compounds having lone pair on central atom and different surrounding atoms.

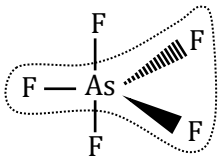
11. **Ans. (3)**

Species	Max. Number of atoms
$BeCl_2$	3
$SnCl_2$	3
SF_2	3
IF_7	6
XeO_3F_2	4

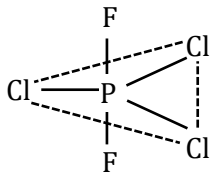
12. **Ans. (1)**

IF_7

13. **Ans. (4)**

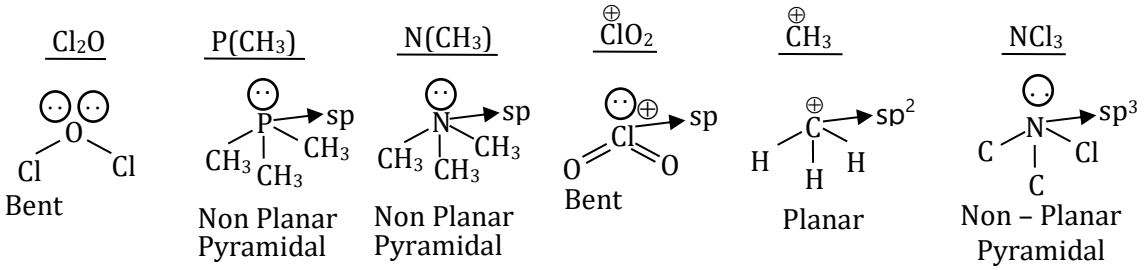


14. **Ans. (4)**



If we consider equatorial plane, there are 4 atoms. Also, there are 4 such planes where we can find maximum 4 atoms in one plane.

15. **Ans. (3)**

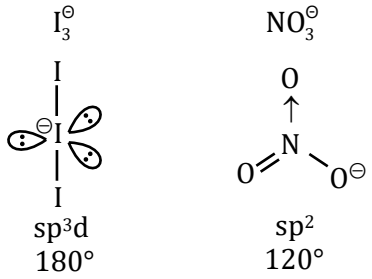


16. **Ans. (4)**

All bond lengths are same in XeF_4, SH_2, $NO_3^{\ominus}$, SiF_4.

Total molecules = 4

17. **Ans. (60)**



Angle difference is 60°.

18. **Ans. (6)**

let total hybrid orbitals be X then

$\%s = \frac{17}{100} \times X = 1$ (as there is only one s orbital in a shell)

$X \cong 6$

So, required atomic orbitals for 17% s character is 6.

19. **Ans. (1)**

PCl_5

20. **Ans. (4)**

$NO_2 \rightarrow$ Form dimer $\rightarrow N_2O_4 \rightarrow$ unpaired electron is localised

$\dot{C}lO_3 \rightarrow$ Form dimer $\rightarrow$ unpaired electron is localised

$\dot{C}lO_2 \rightarrow$ Not form dimer $\rightarrow$ unpaired electron is delocalised

$\dot{C}H_3 \rightarrow$ Form dimer $\rightarrow$ unpaired electron is localised

$\dot{C}F_3 \rightarrow$ Form dimer $\rightarrow$ unpaired electron is localised

21. **Ans. (7)**

μ_{obs} = 1.2 D, % of electronic charge present means % ionic character

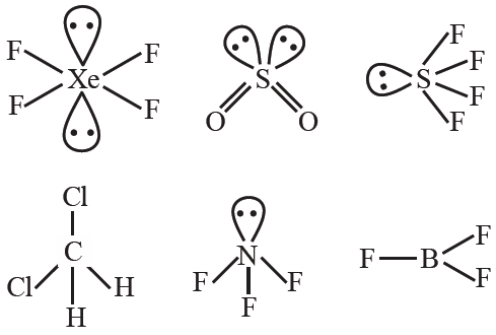
$$\% \text{ ionic character} = \frac{\mu(\text{obsereved})}{\mu(\text{calculated})} \times 100 = \frac{\mu(\text{observed})}{q \times d} \times 100$$

1debye = 10^{-18} esu-cm

$$= \frac{1.2 \times 10^{-18}\ \text{esu.cm}}{4.8 \times 10^{-10}\ \text{esu} \times 10^{-8}\ \text{cm}} \times 100 = 25\%$$

So, answer $\Rightarrow$ 2+5 = 7

22. **Ans. (4)**



Polar molecules : SO_2, SF_4, CH_2Cl_2, NF_3.

23. **Ans. (5)**

$\mu = q \times d$

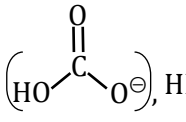
1 D = 10^{-18} esu.cm

$0.40 \times 10^{-18} = 1.6 \times 10^{-8} \times x$

$x = 0.25 \times 10^{-10}$ esu

x = 0.052

24. Ans. (6)

- HF, H_2O_2, HNO_3, H_3BO_3, $Na^{\oplus}$  , $HF_2^{\ominus}$ Shows hydrogen bonding.
- In chloral ($Cl_3C.CHO$) and $HPO_3^{2\ominus}$ no hydrogen is attached with highly electronegative element

25. Ans. (3)

Dipole – Dipole interaction present between (i), (iii) and (iv)

26. Ans. (2)

Two are paramagnetic: O_2^- and B_2.

27. Ans. (4)

Gerade Molecular orbital : σ, π^*, δ

$B_2: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\pi2p_y^1=\pi2p_z^1$

$C_2: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\pi2p_y^2=\pi2p_z^2$

$N_2: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\pi2p_y^2=\pi2p_y^2,\sigma2p_x^2$

$N_2^{2+}: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\pi2p_y^2=\pi2p_z^2$

$N_2^{2-}: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\pi2p_y^2=\pi2p_y^2,\sigma2p_x^2,\pi^*2p_y^1=\pi^*2p_z^1$

$O_2: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\sigma2p_x^2,\ \pi2p_y^2=\pi2p_z^2,\pi^*2p_y^1=\pi^*2p_z^1$

$O_2^{2-}: \sigma1s^2,\sigma^*1s^2,\sigma2s^2,\sigma^*2s^2,\sigma p_x^2,\ \pi2p_y^2=\pi2p_z^2,\pi^*2p_y^2=\pi^*2p_z^2$

Gerade molecular orbitals are "σ and π^*

So, answer is N_2, N_2^{2-}, O_2, O_2^{2-}

28. Ans. (6)

Molecule/Ion	Bond order
B_2	1
C_2	2
O_2^{2-}	1
O_2^+	2.5
H_2^+	0.5
N_2^+	2.5
O_2^-	1.5
H_2	1

29. Ans. (4)

4 (ii, iv, vi, vii)

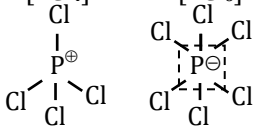
30. Ans. (4)

NO, ClO_2, OF, B_2 are paramagnetic in nature.

EXERCISE - JEE (Main) PYQ

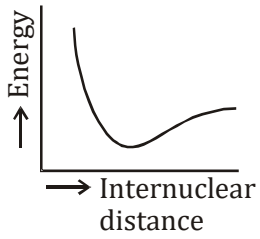
1. Ans. (2)

$2PCl_5(s) \rightarrow [PCl_4]^{\oplus} + [PCl_6]^{\ominus}$



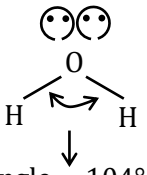
Tetrahedral Octahedral

2. Ans. (2)



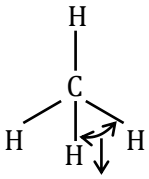
3. Ans. (2)

(1) H_2O



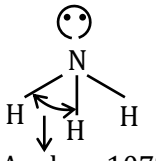
Angle $\simeq$ 104°

(2) CH_4



Angle $\simeq$ 109°28'

(3) NH_3



Angle $\simeq$ 107°

(4) $H_2S \Rightarrow$ No hybridisation, Angle $\simeq$ 90°

4. Ans. (2)

(I) Ion – ion $\propto \frac{1}{r}$

(II) Dipole – dipole $\propto \frac{1}{r^3}$

(III) London dispersion $\propto \frac{1}{r^6}$

5. Ans. (2)

B.P. of $H_2O > H_2S$

↳ Due to extent of hydrogen bonding

6. Ans. (3)

Potential energy of 'A – B' is minimum.

7. **Ans. (1)**

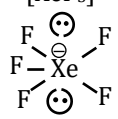
Square Pyramidal → Polar

tetrahedral → Non-Polar

Square planar → Non-Polar

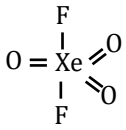
8. **Ans. (1)**

$[XeF_5]^{\ominus}$



Pentagonal planar

XeO_3F_2



Trigonal bipyramidal

9. **Ans. (2)**

Species must not contain single unpaired

(1) $O_2^{\oplus} \rightarrow \sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma_{2s}^{*2} < \sigma_{2pz}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*1} = \pi_{2py}^{*}$

unpaired $e^{\ominus} = 1 \therefore \mu = 1.73$ BM

(1) $Cu^{\oplus}I^{\ominus}$ $Cu^{\oplus} \rightarrow [Ar]3d^{10} \therefore$ unpaired $e^{\ominus} = 0$

$I^{\ominus} \rightarrow [Xe] \therefore$ unpaired $e^{\ominus} = 0$

therefore $\mu = 0$

3. $[Cu(NH_3)_4]Cl_2$

$Cu^{2\oplus} \rightarrow [Ar]\ 3d^9 \therefore$ unpaired $= 1 \therefore \mu = 1.73$ BM

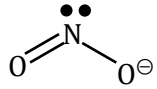
4. $O_2^{\ominus} \rightarrow (17e^{\ominus})$

$\sigma_{1s}^2 < \sigma_{1s}^{*2} < \sigma_{2s}^2 < \sigma_{2s}^{*2} < \sigma_{2px}^2 < \pi_{2px}^2 = \pi_{2py}^2 < \pi_{2px}^{*2} = \pi_{2py}^{*1}$

Unpaired $e^{\ominus} = 1$

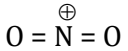
$\therefore \mu = 1.73$ BM

10. **Ans. (4)**



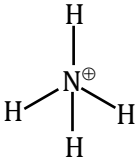
$2\sigma + 1$ lp

$\therefore$ sp^2



$2\sigma + 0$ lp

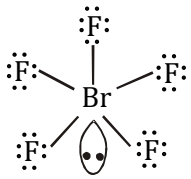
$\therefore$ sp



$4\sigma + 0$ lp

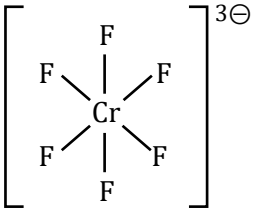
$\therefore$ sp^3

11. **Ans. (3)**



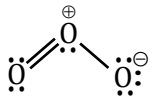
(Square pyramidal)

$[CrF_6]^{3\ominus}$:



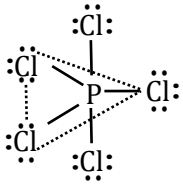
(Octahedral)

O_3 :



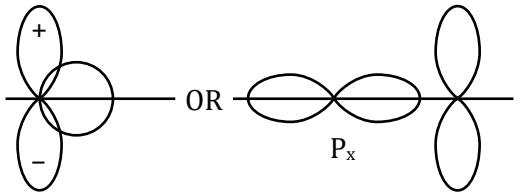
(Bent)

PCl_5 :



(Trigonal bipyramidal)

12. Ans. (1)



Zero overlapping

Zero overlapping due to improper orientation of orbitals

13. Ans. (8)

Peroxodisulphuric acid - $H-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$

No. of π – bonds = 4

Pyro sulphuric acid - $H-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$

No. of π – bonds = 4

Total π – bonds = 8

14. Ans. (1)

N_2 - $\sigma ls^2\ \sigma^* ls^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2\ \underbrace{\sigma 2p_z^2}_{HOMO}$

$N_2^+ - \sigma ls^2\ \sigma^* ls^2\ \sigma^* 2s^2 \sigma^* 2s^2\ \pi 2p_x^2 = \pi 2p_y^2\ \underbrace{\sigma 2p_z^1}_{HOMO}$

$O_2 - \sigma ls^2\ \sigma^* ls^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2$

$\pi 2p_x^2 = \pi 2p_y^2$

$\pi^* 2p_x^1 = \pi^* 2p_y^1 (HOMO)$

$O_2^+ - \sigma ls^2\ \sigma^* ls^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2$

$\pi^* 2p_x^1 = \pi^* 2p_y^0 (HOMO)$

$N_2 \Rightarrow$ 0 unpaired e^- in HOMO

$N_2^+ \Rightarrow$ 1 unpaired e^- in HOMO

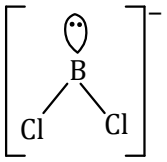
$O_2 \Rightarrow$ 2 unpaired e^- in HOMO

$O_2^+ \Rightarrow$ 1 unpaired e^- in HOMO

15. Ans. (2)

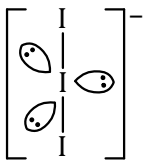
IF_7	zero lone pair
ICl_4^-	two lone pair
XeF_6	one lone pair
XeF_2	three lone pair

16. Ans. (5)

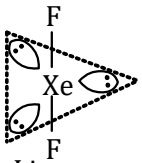
(i) $BCl_2^{\ominus}$ 

V-Shape

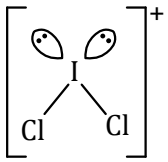
(ii) BeCl Cl—Be—Cl

(iii) I_3^- 

Linear

(iv) XeF_2 

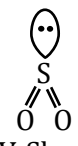
Linear

(v) I_3^+ 

V-Shape

(vi) CO_2 O = C = O
Linear

(vii) C_3O_2 (O=C=C=C=O)
Linear

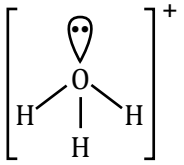
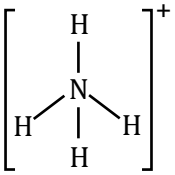
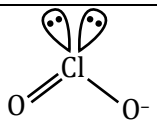
(viii) SO_2 

V-Shape

17. **Ans. (3)**

(a), (b) and (c) are factors which affect the percent covalent character of the ionic bond according to Fajan's rule

18. **Ans. (1)**

Molecule/Ion	Hybridisation	Shape
HO^+	sp^3	Pyramidal 
Acelylide	Sp	linear $\bar{C}\equiv\bar{C}$
NH_4^+	sp^3	tetrahedral 
ClO_2^-	sp^3	Bent 

19. **Ans. (1)**

Acetylide ion $\rightarrow C_2^{2-}(\bar{C}\equiv\bar{C})$

Bond order = 3 & Diamagnetic

NO^+ $14e^- \rightarrow$ Bond order = 3 & Diamagnetic

20. **Ans. (2)**

NO is paramagnetic with BO = 2.5, NO^+ is diamagnetic with BO = 3

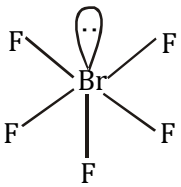
EXERCISE - JEE (Advanced) PYQ

1. **Ans. (4)**

$CuSO_4.5H_2O$ exist as $[Cu(H_2O)_4]\ SO_4.H_2O$

$\therefore$ Four water molecule directly coordinated to $Cu^{2\oplus}$.

2. **Ans. (0)**



According to VSEPR theory all bond angle are < 90°

3. **Ans. (2)**

Elements Na and F show only one non-zero oxidation state in their compounds.

4. **Ans. (B)**

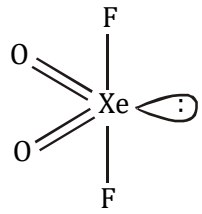
$H_2\underline{C} = \underline{C} = \underline{C}H_2$

sp^2 sp sp^2

5. **Ans. (B)**

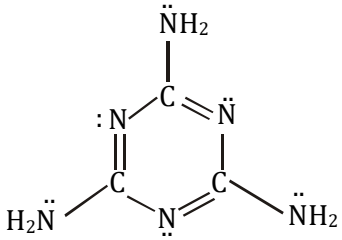
Species :	NH_4Cl	N_2	NO	HNO_3
O.S. of N :	– 3	0	+2	+5

6. **Ans. (D)**



sp^3d See-Saw shape

7. **Ans. (6)**



Total number of L.P. = 6

8. **Ans. (C)**

If 2s–2p mixing is not operative then C_2 becomes paramagnetic.

9. **Ans. (C)**

$P \rightarrow$ d - d σ bonding

$Q \rightarrow$ p - d π bonding

$R \rightarrow$ p - d π anti bonding

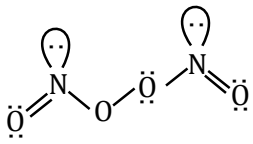
$S \rightarrow$ d - d σ anti bonding

10. **Ans. (4)**

Molecule	**Shape**	**Hybridisation of central atom**
$BeCl_2$	Linear	sp
$N_3^{\ominus}$	Linear	sp
N_2O	Linear	sp
$NO_2^{\oplus}$	Linear	sp
O_3	Bent	sp^2
SCl_2	Bent	sp^3
$ICl_2^{\ominus}$	Linear	sp^3d
$I_3^{\ominus}$	Linear	sp^3d
XeF_2	Linear	sp^3d

The number of linear molecules the central atom does not have contribution from d - orbital = 4

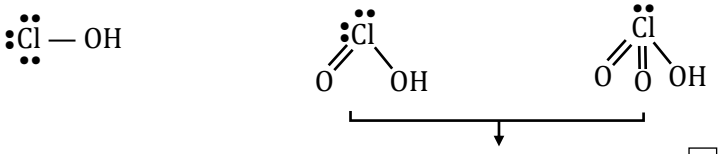
11. **Ans. (8)**



Total number of lone pairs = 8 (Any structure)

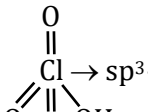
12. **Ans. (B, C)**

(i) $HClO$ (ii) $HClO_2$ (iii) $HClO_3$



Sum of lone pairs on Cl = 2 + 1 = 3 — B Correct

(iv) $HClO_4$



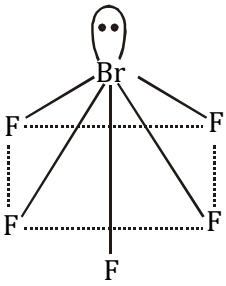
$\rightarrow sp^3$— C Correct

Strongest Acid → D Incorrect

Sum of Cl = 0 bonds in (ii) and (iii) = 1 + 2 = 3

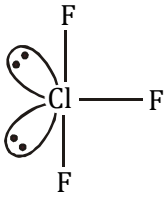
B, C are correct.

13. **Ans. (B, C)**

(A) 

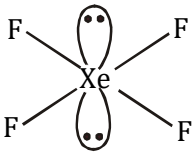
sp^3d^2 hybridisation
Square pyramidal
(Distorted octadehdral)

Number of lone pair on centre atom = 1

(B) 

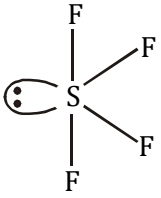
sp^3d hybridisation
T-shape

Number of lone pair on centre atom = 2

(C) 

sp^3d^2 hybridisation
Square planar

Number of lone pair on centre atom = 2

(D) 

sp^3d hybridisation
See-saw

Number of lone pair on centre atom = 1

Hence Answer is (B,C).

14. **Ans. (A,C)**

(A) The molecular orbital energy configuration of $C_2^{2\Theta}$ is

$\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2$

In the MO of $C_2^{2\Theta}$ there is no unpaired electron hence it is diamagnetic

(B) Bond order of $O_2^{2\oplus}$ is 3 and O_2 is 2 therefore bond length of O_2 is greater than $O_2^{2\oplus}$

(C) The molecular orbital energy configuration of $N_2^{\oplus}$ is

$\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^1$

Bond order of $N_2^{\oplus} = \frac{1}{2}(9-4) = 2.5$

The molecular orbital energy configuration of $N_2^{\ominus}$ is

$\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \pi_{2p_x}^2 = \pi_{2p_y}^2, \sigma_{2p_z}^2, \pi_{2p_x}^{*1} = \pi_{2p_y}^{*}$

Bond order of $N_2^{\ominus} = \frac{1}{2}(10-5) = 2.5$

(D) $He_2^{\oplus}$ has less energy as compared to two isolated He atoms

15. Ans. (5 or 6)

$H_2 \Rightarrow \sigma 1s^2$ (Diamagnetic)

$He_2^{\oplus} \Rightarrow \sigma 1s^2 \sigma^* 1s^1$ (Paramagnetic)

$Li_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$ (Diamagnetic)

$Be_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2$ (Diamagnetic)

$B_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \ \pi 2p_x^1 = \pi 2p_y^1$ (Paramagnetic)

$C_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \ \pi 2p_x^2 = \pi 2p_y^2$ (Diamagnetic)

$N_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \ \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$ (Diamagnetic)

$O_2^{\ominus} \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \ \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1$ (Paramagnetic)

$F_2 \Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \ \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^2$ (Diamagnetic)

If existence of Be_2 is considered in atomic form or very weak bonded higher energetic species having zero bond order then it is diamagnetic, then answer will be 6. But if existence of molecular form of Be_2 is not considered then magnetic property can't be predicted then answer will be 5.

16. Ans. (6)

	Number of σ-bonds formed by central atom	Number of lone pairs on central atom
(i) In $[TeBr_6]^{2\ominus}$	6	1
(ii) In $[BrF_2]^{\oplus}$	2	2
(iii) In SNF_3	4	0
(iv) In $[XeF_3]^{\ominus}$	3	3

$\Rightarrow$ Total number of lone pairs of electrons = 1 + 2 + 0 + 3 = 6

17. Ans. (B, D)

Polar molecule : $CHCl_3$, SO_2, C_6H_5Cl, H_2Se, BrF_5, XeF_6, NO_2, NH_3, $POCl_3$, CH_3Cl, O_3

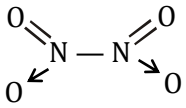
Non-polar molecule : CO_2, $BeCl_2$, BCl_3, SF_6

All polar molecules have permanent dipole moment.

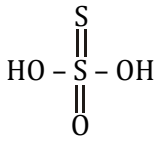
So correct answer is option (B) and (D).

18. **Ans. (4)**

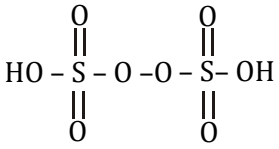
$N \equiv N \rightarrow O \quad \Rightarrow \quad (N_2O)$



$\Rightarrow \quad (N_2O_4)$



$\Rightarrow \quad (H_2S_2O_3)$



$\Rightarrow \quad (H_2S_2O_8)$

19. **Ans. (6)**

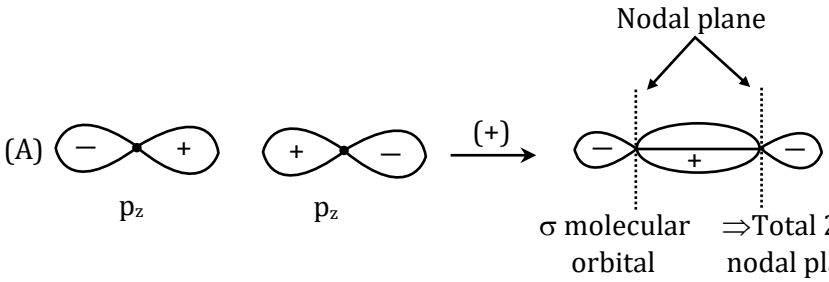
Only polar compounds will show deflection.

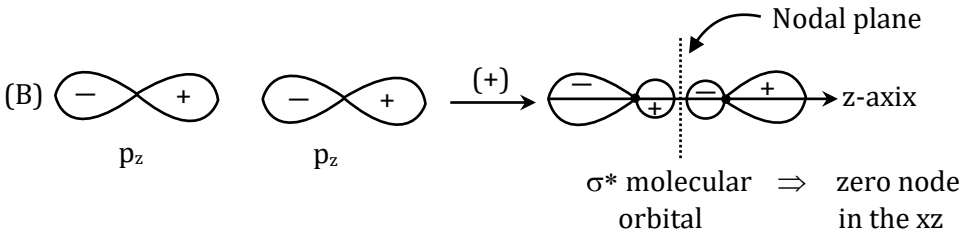
Polar compounds are $\rightarrow$ HF, H_2O, NH_3

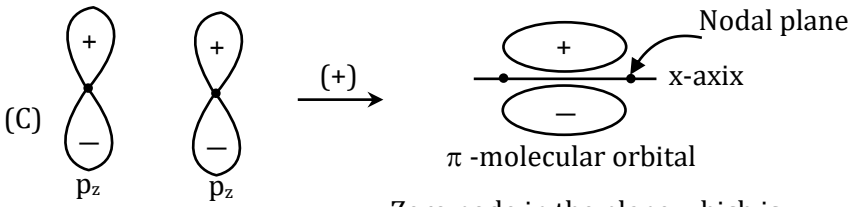
H_2O_2, $CHCl_3$, C_6H_5Cl

Total – 6

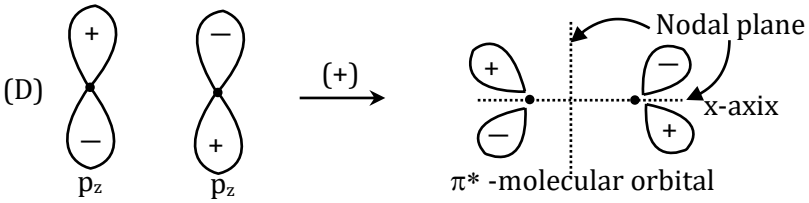
20. **Ans. (A,D)**







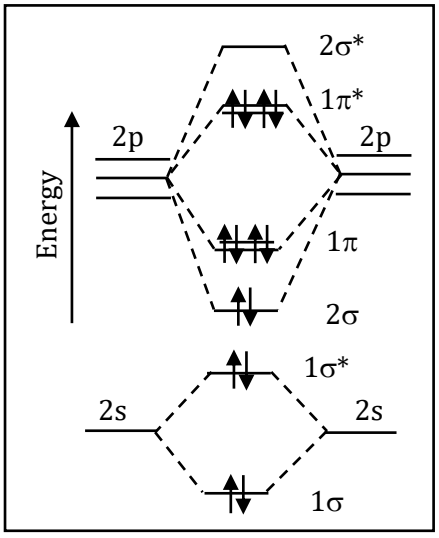
Zero node in the plane which is perpendicular to the molecular axis and goes through the center of the molecular



One node in xy plane containing the molecular axis

21. Ans. (C)

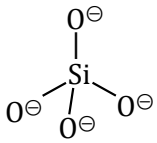
F_2 (18 e^-)

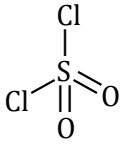


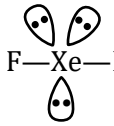
Naming of molecular orbitals are as per preference of formation of σ & π bonds respectively.

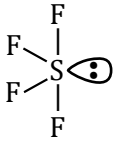
22. Ans. (5)

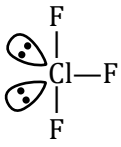
$I_3^{\oplus}$:  : sp^3

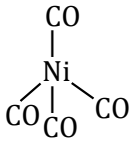
$SiO_4^{4\ominus}$:  : sp^3

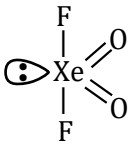
SO_2Cl_2 :  : sp^3

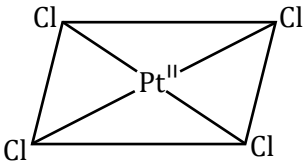
XeF_2 :  : sp^3d

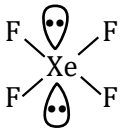
SF_4 :  : sp^3d

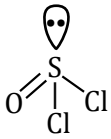
ClF_3 :  : sp^3d

$[Ni(CO)_4]$:  : sp^3

XeO_2F_2 :  : sp^3d

$[PtCl_4]^{2\ominus}$:  : dsp^2

XeF_4 :  : sp^3d^2

$SOCl_2$:  : sp^3

JEE (Main) Practice Paper

SECTION–A

1. Ans. (3)

% Covalent character $\propto$ Polarisation

% C.C. $\propto$ Charge of cation

$$\% \text{ C.C.} \propto \frac{1}{\text{size}}$$

Size order : $Sr^{2\oplus} > Ca^{2\oplus} > Mg^{2\oplus} > Be^{2\oplus}$

% C.C. = $BeCl_2 > MgCl_2 > CaCl_2 > SrCl_2$

2. Ans. (1)

$Li^{\oplus}(aq), Na^{\oplus}(aq), K^{\oplus}(aq), Rb^{\oplus}(aq), Cs^{\oplus}(aq)$

$\longrightarrow$

$r^{\oplus}$ ($\uparrow$), hydrated radii. ($\downarrow$)

3. Ans. (3)

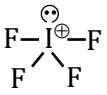
$2p\pi - 2p\pi > 2p\pi - 3d\pi > 2p\pi - 3p\pi > 3p\pi - 3p\pi$.

4. Ans. (2)

Atomic orbitals involved are s, p_x, p_y, p_z, d_{z^2}.

5. **Ans. (4)**

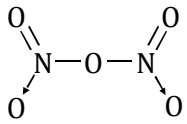
$IF_4^{\oplus}$



See-saw shape

6. **Ans. (2)**

N_2O_5 :



[Co-ordinate and covalent bond]

7. **Ans. (2)**

B.O. : $\frac{NO}{2.5}$ $\frac{NO^{\oplus}}{3}$ $\frac{NO^{\ominus}}{2}$

B.O. $\propto \frac{1}{B.L.}$

B.L. order : $NO^{\ominus} > NO > NO^{\oplus}$

8. **Ans. (4)**

	CO	$CO_3^{2\ominus}$	CO_2
B.O. :	3	1.33	2

B.L.: $CO_3^{2\ominus} > CO_2 > CO$

9. **Ans. (4)**

	N_2	$N_2^{\ominus}$	$N_2^{\oplus}$	$N_2^{2\ominus}$
B.O. :	3	2.5	2.5	2

B.O. $\propto$ B.E.

10. **Ans. (3)**

Strength of H-Bond $\propto$ change accumulated on hydrogen atom.

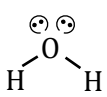
11. **Ans. (3)**

In solid Argon the atoms are held together by Vander Waal forces.

12. **Ans. (2)**

Because BeF_2 is a linear molecule while H_2O has bent shape as following :

H_2O

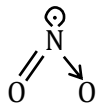


Bent/V-shape

13. **Ans. (4)**

The critical temperature of water is higher than that of O_2 because H_2O is polar molecule while O_2 is non-polar ($\Delta EN = 0$) critical temperature depend on the attraction between molecules. Being polar attraction between H_2O molecules will be more as compare to O_2 molecules.

14. Ans. (4)

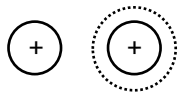


$\theta = 117°$

sp^2 hybridisation

In NO_2 odd electron is present in hybrid orbital and two hybrid orbitals are used in two N–O sigma bonds thus overall three hybrid orbitals are needed in NO_2 molecule. Therefore, NO_2 is sp^2 hybridised. If electronegativity of surrounding atom is more than central atom then odd electron will be present in hybrid orbitals.

15. Ans. (1)



cation anion

Polarisibility $\propto$ change on anion

$\propto$ size of anion

If size of anion is large then electron cloud of anion will be at large distance from the nucleus of anion and will be closer to the nucleus of cation.

Thus, it is easy to deform the electron cloud of anion easily when large size anion is present.

Large anion will be more polarisable.

Correct polarizability order $I^{\ominus} > Br^{\ominus} > Cl^{\ominus} > F^{\ominus}$

16. Ans. (4)

(1) $O_2^{2\oplus}$ (total electron = 14), bond order = 3 (not fractional)

(2) $O_2^{2\ominus}$ (total electron = 18), bond order = 1 (not fractional)

(3) $F_2^{2\ominus}$ (total electron = 20), bond order = 0 (not fractional)

(4) $H_2^{\ominus}$ (total electron = 3), bond order = 0.5 (fractional bond order)

Thus, correct answer is (4)

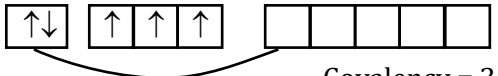
17. Ans. (1)

PCl_5

Due to presence of vacant orbital at low energy level, excitation is possible in P to form 5 bonds with 5 chlorine atoms

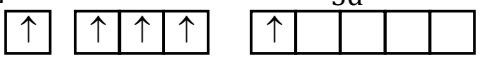
NCl_5

$P \Rightarrow [Ne]\ 3s^2$ $3p^3$ 3d



Covalency = 3

$P^* \Rightarrow [Ne]\ 2s^2$ $2p^3$ $3d^1$

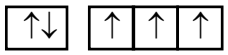


Covalency = 5

Due to absence of vacant orbital at law energy level excitation is not possible in N to form 5 bonds with 5 chlorine atoms.

NCl_5

$N \Rightarrow [He]\ 2s^2 \quad 2p^3$



Due to absence of vacant orbital at low energy level excitation is not possible in N to form 5 bonds with 5 chlorine atoms.

18. Ans. (1)

2s-2p mixing is valid for

$e^{\ominus} \leq 14$

(1) $f_2 \rightarrow 18e^{\ominus}$ (2) $B_2 \rightarrow 10e^{\ominus}$ (3) $N_2 \rightarrow 14e^{\ominus}$ (4) $C_2 \rightarrow 12e^{\ominus}$

19. Ans. (3)

In ice, hydrogen bonding is present and due to hydrogen bonding H_2O molecules are attached to each other. When two ice cubes are pressed over each other molecules stick to each other and form hydrogen bond.

20. Ans. (4)

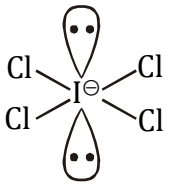
SI_6 does not exist because of steric repulsion due to large size of Iodine atoms.

SECTION-B

1. Ans. (3)

$d_\pi - p_\pi$ is present in : $ClO_3^{\ominus}$, $PO_4^{3\ominus}$, SO_3

2. Ans. (2)



lone pair on I = 2

3. Ans. (3)

$CHCl_3$, CH_2Cl_2 and BF_2Cl have distorted shape.

4. Ans. (0)

(a) x = 4, y = 2

(b) In tetrahedral number of 109° 28' angles

= z = 6

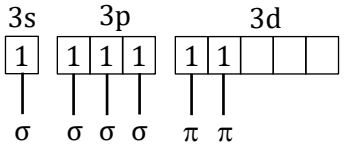
$\Rightarrow$ x + y – z = 4 + 2 – 6 = 0

5. Ans. (0)

$p\pi - p\pi = 0$

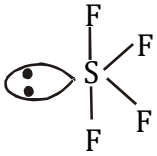
$p\pi - d\pi = 2.$

s : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

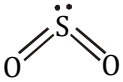


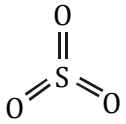
6. Ans. (3)

$SF_2 \rightarrow$  (planar)

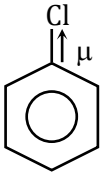
$SF_4 \rightarrow$  (Non-planar)

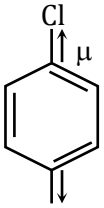
$SF_6 \rightarrow$ Octahedral (Non-planar)

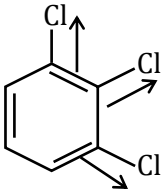
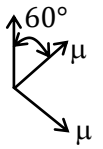
$SO_2 \rightarrow$  (planar)

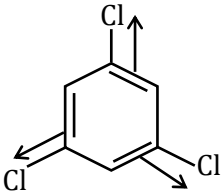
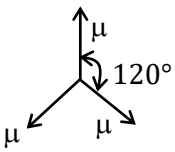
$SO_3 \rightarrow$  planar

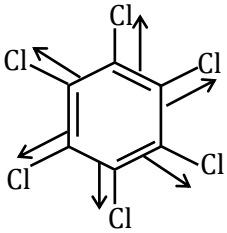
7. Ans. (3)

Given compound  Net dipole moment = μ

  $\mu_{net} = 0$ ✓

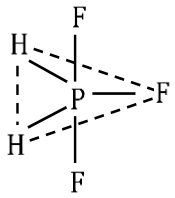
  $\mu_{net} = \mu + \mu\cos60° = 2\mu$ ✗

  $\mu_{net} = 0$ ✓

 All vectors are opposite to each other hence they all cancel each other. $\mu_{net} = 0$ ✓

8. **Ans. (8)**

PH_2F_3 is sp^3d hybridised and T.B.P.



Axial F atom form approx. 90° B.A. from three equatorial atoms.

According to Bent rule equatorial F atom decreases %s-char. Of hybrid orbital so B.A. is less than 120° therefore $HPHB.A. > 120°$ and two $FPHB.A. < 120°$ at equatorial position.

Hence, total eight number of B.A. < 120° (Six by Arial F atoms & two by equatorial.)

9. **Ans. (105)**

For $O_2^{\oplus}$ = $15e^{\ominus}$ M.O. configuration is

$$\sigma 1s^2\, \overset{*}{\sigma} 1s^2, \sigma 2s^2\, \overset{*}{\sigma} 2s^2, \sigma 2pz^2 \pi 2px^2 = \pi 2py^2$$

$$\overset{*}{\pi} 2px^1 = \overset{*}{\pi} 2py$$

Here BMO electrons = 10 & ABMO electrons = 5

So, answer is 105 according to given condition.

10. **Ans. (2)**

M.O. configuration –

$$C_2 = 12e^{\ominus}, \sigma 1s^2\, \overset{*}{\sigma} 1s^2, \sigma 2s^2\, \overset{*}{\sigma} 2s^2, \pi 2px^2 = \pi 2py^2$$

Total 4π electrons

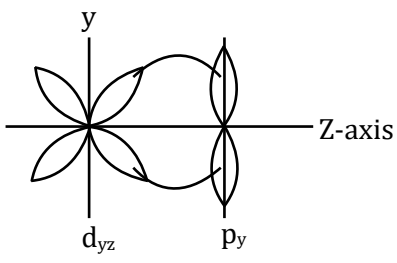
And $B_2 = 10e^{\ominus}, \sigma 1s^2\, \overset{*}{\sigma} 1s^2, \sigma 2s^2\, \overset{*}{\sigma} 2s^2, \pi 2px^1 = \pi 2py^1$

Total 2π electrons

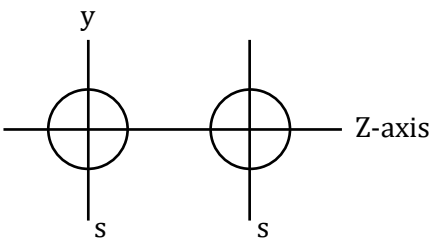
Hence, ratio of π electrons = $\frac{4}{2} = 2$

JEE (Advanced) Practice Paper

1. **Ans. (A)**



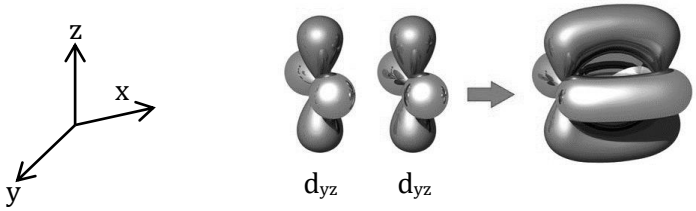
2. Ans. (C)



1 lobe-1 lobe overlap ⇒ σ bond formation

3. Ans. (B)

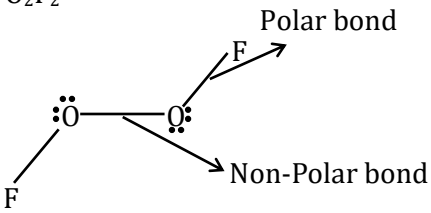
Delta Bond



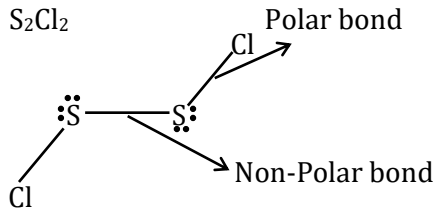
4 lobe – 4 lob over lap ⇒ δ– bond formation

4. Ans. (A,B,C,D)

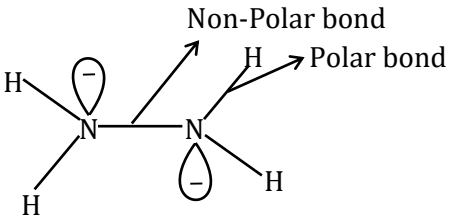
(A) O_2F_2



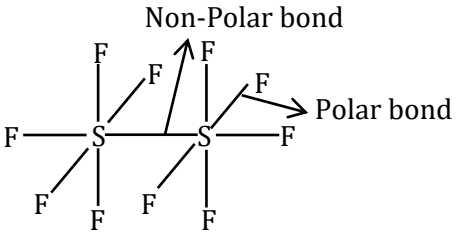
(B) S_2Cl_2



(C) N_2H_4

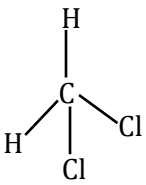


(D) S_2F_{10}



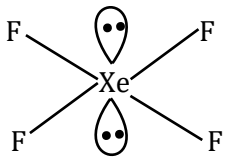
5. Ans. (B, C)

(A) CH_2Cl_2



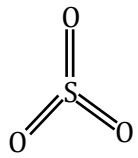
Tetrahedral

(B) XeF_4



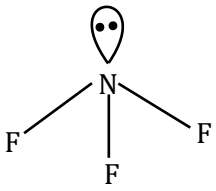
Square planer

(C) SO_3



Trigonal planar

(D) NF_3



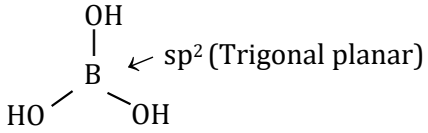
Trigonal pyramidal

6. Ans. (A,B,D)

Polar molecules have Keesom, Debye and London forces.

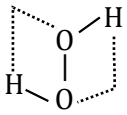
7. Ans. (A,B,C,D)

(A) H_3BO_3 (S)



Intermolecular hydrogen bonding exists

(B) H_2O_2



(Non planar)

In H_2O, Hydrogen bond strength is more as compared to H_2O_2.

(C) In HF extent of hydrogen bonding is less as compared to H_2O.

(D) In KHF_2, $K^{\oplus}$ $[F^{\ominus}—H —F]$

(Hydrogen Bond)

8. Ans. (A,C)

NH_3 = 107; NF_3 = 103° more electronegative F, pull away electron from N

H_2O = 104°; OF_2 = 103° more electronegative F, pull away electron from O

9. Ans. (D)

(P) $C_2 \Rightarrow \sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma_{2s}^{*2} < \pi 2p_x^2 \approx \pi 2p_y^2$

B.O. = 2

(Q) $B_2 \Rightarrow \sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma_{2s}^{*2} < \pi 2p_x^1 \approx \pi 2p_y^1$

B.O. = 1

(R) $O_2 \Rightarrow \sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < \sigma^* 2p_z^2 < \pi 2p_x^2 \approx \pi 2p_y^2 < \pi^* 2p_x^1 \approx \pi^* 2p_y^1$

B.O. = 2

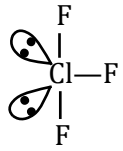
(S) $N_2 \Rightarrow \sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < \pi 2p_x^2 \approx \pi 2p_y^2 < \sigma 2p_z^2$

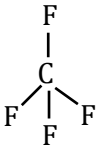
B.O. = 3, B.O. of $CN^{\ominus}$ = 3

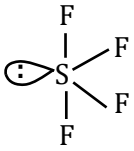
If electron is removed from BMO of molecule then ionisation energy of molecule is more than atom.

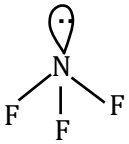
If electron is removed from ABMO of molecule then ionisation energy of molecule is less than atom.

10. Ans. (A)

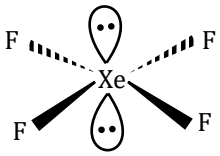
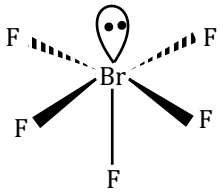
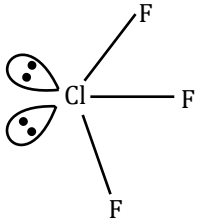
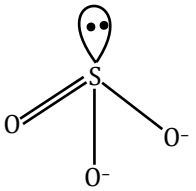
(P)  (3)T Shape

(Q)  (1) Tetrahedral

(R)  (2) See Saw

(S)  (4) Trigonal Pyramidal

11. Ans. (B)

(P) XeF_4	**(Q) BrF_5**	**(R) ClF_3**	**(S) $SO_3^{2\ominus}$**
			
(2) sp^3d^2 hybridized with 2 lone pair on central atom	(4) sp^3d^2 hybridized with 1 lone pair on central atom	(1) sp^3 d hybridized with 2 lone pair on central atom	(3) sp^3 hybridized with 1 lone pair on central atom

12. Ans. (D)

$\mu_{net} = \sqrt{\mu^2+\mu^2+2\mu^2\cos 60^\circ} = \sqrt{3}\mu$

13. Ans. (B)

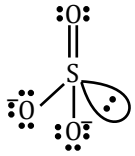
$$\text{Ionic} = \frac{\mu_{obs}}{\mu_{theo}}\times 100 = \frac{1.2\times10^{-18}\text{esu cm}\times100}{4.8\times10^{-10}\times\text{esu}\times10^{-8}\text{cm}} = 25\%$$

$\Rightarrow$ % covalent = 100 – 25 = 75%

14. Ans. (D)

Hypovalent species (species having less than 8 $e^{\ominus}$), hypervalent (species having more than 8 $e^{\ominus}$) & odd $e^{\ominus}$ species are exceptions of octet rule.

15. Ans. (C)



Total number of bond pairs = 4

Total number of lone pairs = 9

16. Ans. (5)

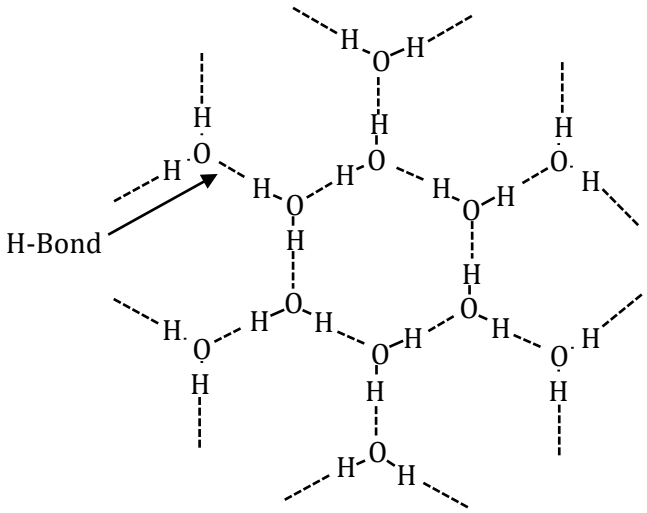
(i) σ	(ii) π	(iii) π	(iv) π
(v) π	(vi) π	(vii) no bond	(viii) δ

17. Ans. (5)

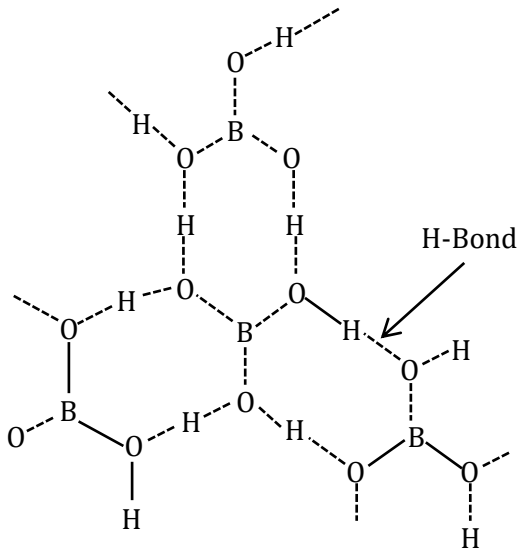
species having fractional bond order → $N_2^{\oplus}$, $N_2^{\ominus}$, $O_2^{\oplus}$, $B_2^{\oplus}$, $C_2^{\oplus}$

Species		Bond Order
$N_2^{\oplus}$	→	2.5
$N_2^{\ominus}$	→	2.5
O_2	→	2
$O_2^{\oplus}$	→	2.5
F_2	→	1
$B_2^{\oplus}$	→	0.5
$C_2^{\oplus}$	→	1.5
$CN^{\ominus}$	→	3
$NO^{\oplus}$	→	3

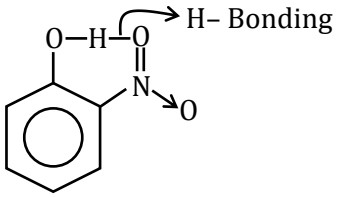
18. Ans. (4)



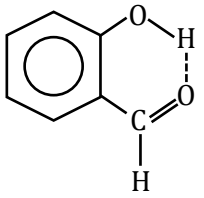
Ice (Intermolecular H-Bond)



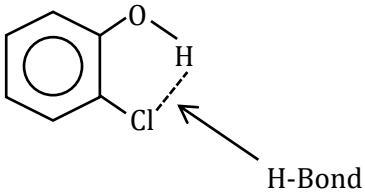
Boric acid (Intermolecular H-bond)



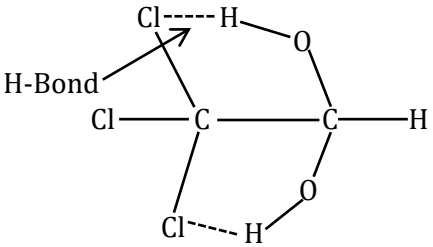
Ortho Nitro-phenol
(Intramolecular H-bond)



o-salicyaldehyde
(Intramolecular H-bond)

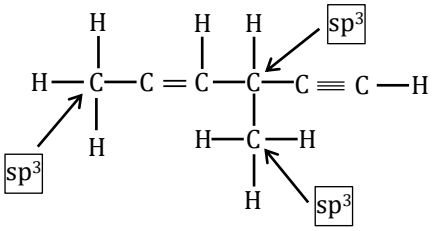


o-chlorophenol
(Intramolecular H-bond)



Chloral hydrate (Intramolecular H-bond)

19. Ans. (3)



20. Ans. (1)

sp^3 hybridized P atom = 3

sp^2 hybridized N atom = 3