Chapter 4

Chemical Bonding and Molecular Structure

1. Using MO theory predict which of the following species has the shortest bond length? **[AIEEE-2009]**

   (1) O_2^+ (2) O_2^-

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

2. In which of the following pairs the two species are not isostructural? **[AIEEE-2012]**

   (1) PCl_4^+ and $SiCl_4$ (2) PF_5 and BrF_5

   (3) AlF_6^{3-} and SF_6 (4) CO_3^{2-} and NO_3^-

3. ortho-Nitrophenol is less soluble in water than p - and m - Nitrophenols because **[AIEEE-2012]**

   (1) o - Nitrophenol shows Intramolecular H - bonding

   (2) o - Nitrophenol shows Intermolecular H - bonding

   (3) Melting point of o - Nitrophenol is lower than those of m - and p - isomers

   (4) o - Nitrophenol is more volatile in steam than those of m - and p - isomers

4. Which one of the following molecules is expected to exhibit diamagnetic behaviour? **[JEE (Main)-2013]**

   (1) C_2 (2) N_2^+

   (3) O_2 (4) S_2

5. In which of the following pairs of molecules/ions, both the species are not likely to exist? **[JEE (Main)-2013]**

   (1) H_2^+, He_2^{2-} (2) H_2^-, He_2^{2-}

   (3) H_2^{2+}, He_2 (4) H_2^-, He_2^{2+}

6. Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of **[JEE (Main)-2013]**

   (1) $Li_2 < Li_2^+ < Li_2^-$ (2) $Li_2^- < Li_2^+ < Li_2$

   (3) $Li_2 < Li_2^- < Li_2^+$ (4) $Li_2^- < Li_2 < Li_2^+$

7. For which of the following molecule significant $\mu \neq 0$? **[JEE (Main)-2014]**

   (a) 

   (b) 

   (c) 

   (d) 

   (1) Only (a)] (2) (a) and (b)

   (3) Only (c) (4) (c) and (d)

8. The species in which the N atom is in a state of *sp* hybridization is **[JEE (Main)-2016]**

   (1) NO_2^- (2) NO_3^-

   (3) NO_2 (4) NO_2^+

9. Which of the following species is not paramagnetic? **[JEE (Main)-2017]**

   (1) O_2 (2) B_2

   (3) NO (4) CO

10. According to molecular orbital theory, which of the following will not be a viable molecule? **[JEE (Main)-2018]**

    (1) He_2^{2+} (2) He_2^+

    (3) H_2^- (4) H_2^{2-}

11. Which of the following compounds contain(s) no covalent bond(s)? **[JEE (Main)-2018]**

    KCl, PH_3, O_2, B_2H_6, H_2SO_4

    (1) KCl, B_2H_6, PH_3 (2) KCl, H_2SO_4

    (3) KCl (4) KCl, B_2H_6

12. Total number of lone pair of electrons in I_3^- ion is **[JEE (Main)-2018]**

(1) 3 (2) 6

(3) 9 (4) 12

13. According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^- ? **[JEE (Main)-2019]**

(1) Li_2^+ is unstable and Li_2^- is stable

(2) Li_2^+ is stable and Li_2^- is unstable

(3) Both are stable

(4) Both are unstable

14. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic? **[JEE (Main)-2019]**

(1) $N_2 \rightarrow N_2^+$ (2) $O_2 \rightarrow O_2^+$

(3) $O_2 \rightarrow O_2^{2-}$ (4) $NO \rightarrow NO^+$

15. The type of hybridisation and number of lone pair(s) of electrons of Xe in $XeOF_4$, respectively, are **[JEE (Main)-2019]**

(1) sp^3d and 2 (2) sp^3d^2 and 2

(3) sp^3d^2 and 1 (4) sp^3d and 1

16. Two pi and half sigma bonds are present in **[JEE (Main)-2019]**

(1) O_2^+ (2) O_2

(3) N_2^+ (4) N_2

17. The correct statement about ICl_5 and ICl_4^- is **[JEE (Main)-2019]**

(1) ICl_5 is square pyramidal and ICl_4^- is tetrahedral.

(2) Both are isostructural.

(3) ICl_5 is square pyramidal and ICl_4^- is square planar.

(4) ICl_5 is trigonal bipyramidal and ICl_4^- is tetrahedral.

18. The ion that has sp^3d^2 hybridization for the central atom, is **[JEE (Main)-2019]**

(1) $[ICl_2]^-$ (2) $[IF_6]^-$

(3) $[BrF_2]^-$ (4) $[ICl_4]^-$

19. Among the following molecules/ions,

C_2^{2-}, N_2^{2-}, O_2^{2-}, O_2

Which one is diamagnetic and has the shortest bond length? **[JEE (Main)-2019]**

(1) O_2 (2) O_2^{2-}

(3) N_2^{2-} (4) C_2^{2-}

20. Among the following, the molecule expected to be stabilized by anion formation is **[JEE (Main)-2019]**

C_2, O_2, NO, F_2

(1) F_2 (2) NO

(3) C_2 (4) O_2

21. HF has highest boiling point among hydrogen halides, because it has **[JEE (Main)-2019]**

(1) Strongest hydrogen bonding

(2) Lowest dissociation enthalpy

(3) Strongest van der Waals' interactions

(4) Lowest ionic character

22. Among the following species, the diamagnetic molecule is **[JEE (Main)-2019]**

(1) CO (2) NO

(3) O_2 (4) B_2

23. During the change of O_2 to O_2^-, the incoming electron goes to the orbital **[JEE (Main)-2019]**

(1) $\pi 2p_x$ (2) $\pi^* 2p_x$

(3) $\pi 2p_y$ (4) $\sigma^* 2p_z$

24. The relative strength of interionic/intermolecular forces in decreasing order is **[JEE (Main)-2020]**

(1) ion-ion > ion-dipole > dipole-dipole

(2) ion-dipole > dipole-dipole > ion-ion

(3) ion-dipole > ion-ion > dipole-dipole

(4) dipole-dipole > ion-dipole > ion-ion

25. The bond order and the magnetic characteristics of CN^- are **[JEE (Main)-2020]**

(1) $2\frac{1}{2}$, paramagnetic (2) 3, diamagnetic

(3) $2\frac{1}{2}$, diamagnetic (4) 3, paramagnetic

26. The predominant intermolecular forces present in ethyl acetate, a liquid, are **[JEE (Main)-2020]**

(1) Dipole-dipole and hydrogen bonding

(2) London dispersion and dipole-dipole

(3) Hydrogen bonding and London dispersion

(4) London dispersion, dipole-dipole and hydrogen bonding

27. Arrange the following bonds according to their average bond energies in descending order

C – Cl, C – Br, C – F, C – I **[JEE (Main)-2020]**

(1) C – Cl > C – Br > C – I > C – F

(2) C – Br > C – I > C – Cl > C – F

(3) C – F > C – Cl > C – Br > C – I

(4) C – I > C – Br > C – Cl > C – F

28. If the magnetic moment of a dioxygen species is 1.73 B.M, it may be **[JEE (Main)-2020]**

(1) O_2^- or O_2^+ (2) O_2, O_2^- or O_2^+

(3) O_2 or O_2^+ (4) O_2 or O_2^-

29. If AB_4 molecule is a polar molecule, a possible geometry of AB_4 is **[JEE (Main)-2020]**

(1) Tetrahedral (2) Rectangular planar

(3) Square pyramidal (4) Square planar

30. The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order : **[JEE (Main)-2020]**

(1) $CCl_4 < CH_4 < CHCl_3$ (2) $CHCl_3 < CH_4 = CCl_4$

(3) $CH_4 = CCl_4 < CHCl_3$ (4) $CH_4 < CCl_4 < CHCl_3$

31. Match the type of interaction in column A with the distance dependence of their interaction energy in column B

A	B
(i) ion-ion	(a) $\frac{1}{r}$
(ii) dipole-dipole	(b) $\frac{1}{r^2}$
(iii) London dispersion	(c) $\frac{1}{r^3}$
	(d) $\frac{1}{r^6}$

[JEE (Main)-2020]

(1) (I)-(a), (II)-(b), (III)-(d)

(2) (I)-(b), (II)-(d), (III)-(c)

(3) (I)-(a), (II)-(b), (III)-(c)

(4) (I)-(a), (II)-(c), (III)-(d)

32. The molecular geometry of SF_6 is octahedral. What is the geometry of SF_4 (including lone pair(s) of electrons, if any)? **[JEE (Main)-2020]**

(1) Tetrahedral

(2) Trigonal bipyramidal

(3) Square planar

(4) Pyramidal

33. The shape / structure of $[XeF_5]^-$ and XeO_3F_2, respectively, are **[JEE (Main)-2020]**

(1) Pentagonal planar and trigonal bipyramidal

(2) Trigonal bipyramidal and pentagonal planar

(3) Octahedral and square pyramidal

(4) Trigonal bipyramidal and trigonal bipyramidal

34. If the boiling point of H_2O is 373 K, the boiling point of H_2S will be **[JEE (Main)-2020]**

(1) Less than 300 K

(2) More than 373 K

(3) Equal to 373 K

(4) Greater than 300 K but less than 373 K

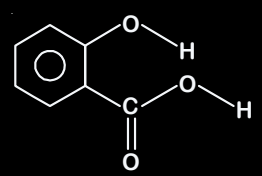
35. Of the species, NO, NO^+, NO^{2+} and NO^-, the one with minimum bond strength is **[JEE (Main)-2020]**

(1) NO^- (2) NO^{2+}

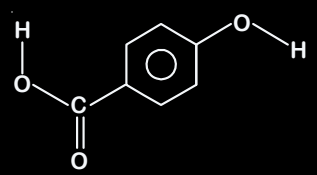
(3) NO^+ (4) NO

36. Consider the following molecules and statements related to them

(A)



(B)



(a) (B) is more likely to be crystalline than (A)

(b) (B) has higher boiling point than (A)

(c) (B) dissolves more readily than (A) in water

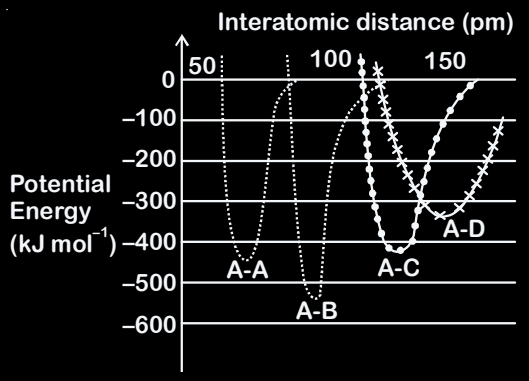
Identify the correct option from below

[JEE (Main)-2020]

(1) (a) and (c) are true (2) Only (a) is true

(3) (b) and (c) are true (4) (a) and (b) are true

37. The intermolecular potential energy for the molecules A, B, C and D given below suggests that



[JEE (Main)-2020]

(1) A-B has the stiffest bond

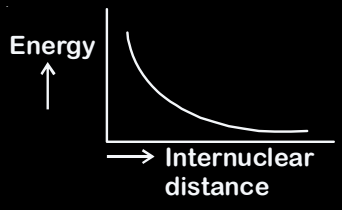
(2) A-D has the shortest bond length

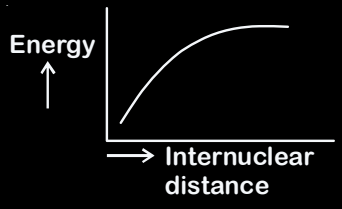
(3) A-A has the largest bond enthalpy

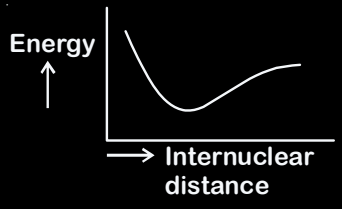
(4) D is more electronegative than other atoms

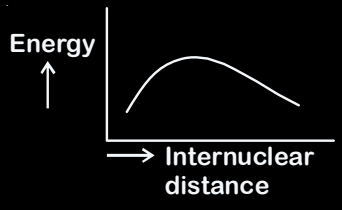
38. The potential energy curve for the H_2 molecule as a function of internuclear distance is

[JEE (Main)-2020]

(1)


(2)


(3)


(4)


39. The compound that has the largest H – M – H bond angle (M = N, O, S, C) is **[JEE (Main)-2020]**

(1) H_2S (2) CH_4

(3) NH_3 (4) H_2O

40. Which of the following are isostructural pairs?

[JEE (Main)-2021]

A. SO_4^{2-} and CrO_4^{2-}

B. $SiCl_4$ and $TiCl_4$

C. NH_3 and NO_3^-

D. BCl_3 and $BrCl_3$

(1) A and C only (2) B and C only

(3) A and B only (4) C and D only

41. The correct shape and I – I – I bond angles respectively in I_3^- ion are: **[JEE (Main)-2021]**

(1) Distorted trigonal planar; 135° and 90°

(2) Trigonal planar; 120°

(3) T-shaped; 180° and 90°

(4) Linear; 180°

42. According to molecular orbital theory, the species among the following that does not exist is

[JEE (Main)-2021]

(1) He_2^- (2) Be_2

(3) He_2^+ (4) O_2^{2-}

43. Which among the following species has unequal bond lengths? **[JEE (Main)-2021]**

(1) XeF_4 (2) BF_4^-

(3) SF_4 (4) SiF_4

44. Match list-I with list-II

List-I (Molecule)	List-II (Bond order)
(a) Ne_2	(i) 1
(b) N_2	(ii) 2
(c) F_2	(iii) 0
(d) O_2	(iv) 3

Choose the correct answer from the options given below **[JEE (Main)-2021]**

(1) (a)-(iv); (b)-(iii); (c)-(ii); (d)-(i)

(2) (a)-(ii); (b)-(i); (c)-(iv); (d)-(iii)

(3) (a)-(i); (b)-(ii); (c)-(iii); (d)-(iv)

(4) (a)-(iii); (b)-(iv); (c)-(i); (d)-(ii)

45. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : The H – O – H bond angle in water molecule is 104.5°.

Reason R : The lone pair - lone pair repulsion of electrons is higher than the bond pair - bond pair repulsion.

In the light of the above statements, choose the **correct** answer from the options given below.

[JEE (Main)-2021]

(1) **A** is false but **R** is true

(2) **A** is true but **R** is false

(3) Both **A** and **R** are true, and **R** is the correct explanation of **A**

(4) Both **A** and **R** are true, but **R** is not the correct explanation of **A**

46. A central atom in a molecule has two lone pairs of electrons and forms three single bonds. The shape of this molecule is **[JEE (Main)-2021]**

(1) Trigonal pyramidal

(2) See-saw

(3) T-shaped

(4) Planar triangular

47. Amongst the following, the linear species is

[JEE (Main)-2021]

(1) N_3^- (2) NO_2

(3) O_3 (4) Cl_2O

48. AX is a covalent diatomic molecule where A and X are second row elements of periodic table. Based on Molecular orbital theory, the bond order of AX is 2.5. The total number of electrons in AX is _____. **[JEE (Main)-2021]**

(Round off to the Nearest Integer).

49. The number of species below that have two lone pairs of electrons in their central atom is _____. (Round off to the Nearest Integer).

[JEE (Main)-2021]

SF_4, BF_4^-, ClF_3, AsF_3, PCl_5, XeF_4, SF_6

50. The number of lone pairs of electrons on the central I atom in I_3^- is _____. **[JEE (Main)-2021]**

51. The hybridisations of the atomic orbitals of nitrogen in NO_2^-, NO_2^+ and NH_4^+ respectively are :

[JEE (Main)-2021]

(1) sp^3, sp^2 and sp (2) sp, sp^2 and sp^3

(3) sp^2, sp and sp^3 (4) sp^3, sp and sp^2

52. Match List-I with List-II

List-I (Species)	**List-I (Hybrid Orbitals)**
(a) SF_4	(i) sp^3d^2
(b) IF_5	(ii) d^2sp^3
(c) NO_2^+	(iii) sp^3d
(d) NH_4^+	(iv) sp^3
	(v) sp

Choose the correct answer from the options given below : **[JEE (Main)-2021]**

(1) (a)-(ii), (b)-(i), (c)-(iv) and (d)-(v)

(2) (a)-(iv), (b)-(iii), (c)-(ii) and (d)-(v)

(3) (a)-(i), (b)-(ii), (c)-(v) and (d)-(iii)

(4) (a)-(iii), (b)-(i), (c)-(v) and (d)-(iv)

53. The number of sigma bonds in

[JEE (Main)-2021]

54. In the following the correct bond order sequence is : **[JEE (Main)-2021]**

(1) $O_2^+ > O_2^- > O_2^{2-} > O_2$

(2) $O_2^+ > O_2 > O_2^- > O_2^{2-}$

(3) $O_2^{2-} > O_2^+ > O_2^- > O_2$

(4) $O_2 > O_2^- > O_2^{2-} > O_2^+$

55. Identify the species having one π-bond and maximum number of canonical forms from the following : **[JEE (Main)-2021]**

(1) SO_2 (2) O_2

(3) CO_3^{2-} (4) SO_3

56. The difference between bond orders of CO and $NO^{\oplus}$ is $\frac{x}{2}$ where x = _____. (Round off to the Nearest Integer) **[JEE (Main)-2021]**

57. The total number of electrons in all bonding molecular orbitals of O_2^{2-} is _____.
(Round off to the Nearest Integer).
[JEE (Main)-2021]

58. AB_3 is an interhalogen T-shaped molecule. The number of lone pairs of electrons on A is _____. (Integer answer) **[JEE (Main)-2021]**

59. The bond order and magnetic behaviour of O_2^- ion are, respectively: **[JEE (Main)-2021]**
(1) 1.5 and diamagnetic.
(2) 1.5 and paramagnetic.
(3) 1 and paramagnetic.
(4) 2 and diamagnetic.

60. The number of species having non-pyramidal shape among the following is _____. **[JEE (Main)-2021]**
(1) SO_3 (2) NO_3^-
(3) PCl_3 (4) CO_3^{2-}

61. According to molecular orbital theory, the number of unpaired electron(s) in O_2^{2-} is _____.
[JEE (Main)-2021]

62. Number of paramagnetic oxides among the following given oxides is _____. **[JEE (Main)-2021]**
Li_2O, CaO, Na_2O_2, KO_2, MgO and K_2O
(1) 3 (2) 2
(3) 1 (4) 0

63. The spin-only magnetic moment value of B_2^+ species is _____ × 10^{-2} BM. (Nearest integer)
[Given : $\sqrt{3} = 1.73$] **[JEE (Main)-2021]**

64. The correct order of bond orders of C_2^{2-}, N_2^{2-}, O_2^{2-} is, respectively **[JEE (Main)-2022]**
(1) $C_2^{2-} < N_2^{2-} < O_2^{2-}$ (2) $O_2^{2-} < N_2^{2-} < C_2^{2-}$
(3) $C_2^{2-} < O_2^{2-} < N_2^{2-}$ (4) $N_2^{2-} < C_2^{2-} < O_2^{2-}$

65. Number of electron deficient molecules among the following
PH_3, B_2H_6, CCl_4, NH_3, LiH and BCl_3 is
[JEE (Main)-2022]
(1) 0 (2) 1
(3) 2 (4) 3

66. Amongst BeF_2, BF_3, H_2O, NH_3, CCl_4 and HCl, the number of molecules with non-zero net dipole moment is _____. **[JEE (Main)-2022]**

67. Consider the ions/molecules
O_2^+, O_2, O_2^-, O_2^{2-}
For increasing bond order the correct option is:
[JEE (Main)-2022]
(1) $O_2^{2-} < O_2^- < O_2 < O_2^+$ (2) $O_2^- < O_2^{2-} < O_2 < O_2^+$
(3) $O_2^- < O_2^{2-} < O_2^+ < O_2$ (4) $O_2^- < O_2^+ < O_2^{2-} < O_2$

68. Amongst SF_4, XeF_4, CF_4 and H_2O, the number of species with two lone pair of electrons is _____.
[JEE (Main)-2022]

69. Based upon VSEPR theory, match the shape (geometry) of the molecules in **List-I** with the molecules in **List-II** and select the **most appropriate** option. **[JEE (Main)-2022]**

List-I (Shape)	**List-II (Molecules)**
(A) T-shaped	(I) XeF_4
(B) Trigonal planar	(II) SF_4
(C) Square planar	(III) ClF_3
(D) See-saw	(IV) BF_3

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(2) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(3) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(4) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

70. Identify the **incorrect** statement for PCl_5 from the following. **[JEE (Main)-2022]**
(1) In this molecule, orbitals of phosphorous are assumed to undergo sp^3d hybridization.
(2) The geometry of PCl_5 is trigonal bipyramidal.
(3) PCl_5 has two axial bonds stronger than three equatorial bonds.
(4) The three equatorial bonds of PCl_5 lie in a plane

71. The correct order of increasing intermolecular hydrogen bond strength is **[JEE (Main)-2022]**

(1) $HCN < H_2O < NH_3$

(2) $HCN < CH_4 < NH_3$

(3) $CH_4 < HCN < NH_3$

(4) $CH_4 < NH_3 < HCN$

72. The hybridization of P exhibited in PF_5 is sp^xd^y. The value of y is _____ **[JEE (Main)-2022]**

73. In the structure of SF_4, the lone pair of electrons on S is in. **[JEE (Main)-2022]**

(1) Equatorial position and there are two lone pair - bond pair repulsions at 90º

(2) Equatorial position and there are three lone pair - bond pair repulsions at 90º

(3) Axial position and there are three lone pair - bond pair repulsion at 90º

(4) Axial position and there are two lone pair - bond pair repulsion at 90º

74. Arrange the following in the decreasing order of their covalent character : **[JEE (Main)-2022]**

(A) LiCl (B) NaCl

(C) KCl (D) CsCl

Choose the **most appropriate** answer from the options given below :

(1) (A) > (C) > (B) > (D)

(2) (B) > (A) > (C) > (D)

(3) (A) > (B) > (C) > (D)

(4) (A) > (B) > (D) > (C)

75. Number of lone pair(s) of electrons on central atom and the shape of BrF_3 molecule respectively, are **[JEE (Main)-2022]**

(1) 0, triangular planar (2) 1, pyramidal

(3) 2, bent T-shape (4) 1, bent T-shape

76. Among the following species

$N_2, N_2^+, N_2^-, N_2^{2-}, O_2, O_2^+, O_2^-, O_2^{2-}$

the number of species showing diamagnetism is _____. **[JEE (Main)-2022]**

77. Match **List-I** with **List-II** :

List-I (Molecule)	**List-II (hybridization; shape)**
A. XeO_3	I. sp^3d; linear
B. XeF_2	II. sp^3; pyramidal
C. $XeOF_4$	III. sp^3d^3; distorted octahedral
D. XeF_6	IV. sp^3d^2; square pyramidal

Choose the correct answer from the options given below: **[JEE (Main)-2022]**

(1) A-II, B-I, C-IV, D-III

(2) A-II, B-IV, C-III, D-I

(3) A-IV, B-II, C-III, D-I

(4) A-IV, B-II, C-I, D-III

78. The sum of number of lone pairs of electrons present on the central atoms of XeO_3, $XeOF_4$ and XeF_6, is_____ **[JEE (Main)-2022]**

79. Match **List-I** with **List-II.**

List-I (Compound)	**List-II (Shape)**
(A) BrF_5	(I) bent
(B) $[CrF_6]^{3-}$	(II) square pyramidal
(C) O_3	(III) trigonal bipyramidal
(D) PCl_5	(IV) octahedral

Choose the **correct** answer from the options given below : **[JEE (Main)-2022]**

(1) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(3) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

(4) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

80. Arrange the following in increasing order of their covalent character.

A. CaF_2 B. $CaCl_2$

C. $CaBr_2$ D. CaI_2

Choose the correct answer from the option given below. **[JEE (Main)-2022]**

(1) B < A < C < D (2) A < B < C < D

(3) A < B < D < C (4) A < C < B < D

81. According to MO theory, number of species/ions from the following having identical bond order is ___.

$CN^-, NO^+, O_2, O_2^+, O_2^{2+}$ **[JEE (Main)-2022]**

82. Match List-I with List -II

List-I	List-II
(A) $\Psi_{MO} = \Psi_A - \Psi_B$	(I) Dipole moment
(B) $\mu = Q \times r$	(II) Bonding molecular orbital
(C) $\frac{N_b - N_a}{2}$	(III) Anti-bonding molecular orbital
(D) $\Psi_{MO} = \Psi_A + \Psi_B$	(IV) Bond order

Choose the correct answer from options given below: **[JEE (Main)-2022]**

(1) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(2) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

(4) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

83. The number of molecul(s) or ion(s) from the following having non-planar structure is ____.

$NO_3^-, H_2O_2, BF_3, PCl_3, XeF_4, SF_4, SF_4,$

$XeO_3, PH_4^+, SO_3, [Al(OH)_4]^-$ **[JEE (Main)-2022]**

84. The number of paramagnetic species among the following is _____.

$B_2, Li_2, C_2, C_2^-, O_2^{2-}, O_2^+$ and He_2^+

[JEE (Main)-2022]

85. Given below are two statements: One is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A: Zero orbital overlap is an out of phase overlap.

Reason R: It results due to different orientation/ direction of approach of orbitals.

In the light of the above statements, choose the **correct** answer from the options given below

[JEE (Main)-2022]

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

(2) Both A and R are true but R is NOT the correct explanation of A

(3) A is true but R is false

(4) A is false but R is true

86. Which of the following pair of molecules contain odd electron molecule and an expanded octet molecule? **[JEE (Main)-2022]**

(1) BCl_3 and SF_6 (2) NO and H_2SO_4

(3) SF_6 and H_2SO_4 (4) BCl_3 and NO

87. Number of lone pairs of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6, respectively, are:

[JEE (Main)-2022]

(1) 0, 1, 2 and 2 (2) 2, 1, 2 and 0

(3) 1, 2, 2 and 0 (4) 2, 1, 0 and 2

88. Consider, PF_5, BrF_5, PCl_3, SF_6, $[ICl_4]^-$, ClF_3 and IF_5.

Amongst the above molecule(s)/ion(s), the number of molecule(s)/ion(s) having sp^3d^2 hybridisation is _____. **[JEE (Main)-2022]**

89. Consider the species CH_4, NH_4^+ and BH_4^-. Choose the correct option with respect to these species.

[JEE (Main)-2022]

(1) They are isoelectronic and only two have tetrahedral structures

(2) They are isoelectronic and all have tetrahedral structures.

(3) Only two are isoelectronic and all have tetrahedral structures.

(4) Only two are isoelectronic and only two have tetrahedral structures.

90. Bonding in which of the following diatomic molecule(s) become(s) stronger, on the basis of MO Theory, by removal of an electron?

(A) NO (B) N_2

(C) O_2 (D) C_2

(E) B_2

Choose the **most appropriate** answer from the options given below :

[JEE (Main)-2022]

(1) (A), (B), (C) only

(2) (B), (C), (E) only

(3) (A), (C) only

(4) (D) only

❑ ❑ ❑

Chapter 4

Chemical Bonding and Molecular Structure

1. Answer (4)

   Higher is the bond order, shorter is the bond length.

   Bond order of O_2^{2+} is 3.0

2. Answer (2)

3. Answer (1)

4. Answer (1)

   The electronic configuration of the given diatomic molecules is

   C_2: $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p_x}^2\pi_{2p_y}^2$

   N_2^+: $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p_x}^2\pi_{2p_y}^2\sigma_{2p_z}^1$

   O_2: $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2\pi_{2p_x}^{*1}\pi_{2p_y}^{*1}$

   S_2: $\sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2\pi_{2p_x}^{*2}\pi_{2p_y}^{*2}$
   $\sigma_{2p_z}^{*2}\sigma_{3s}^2\sigma_{3s}^{*2}\sigma_{3p_z}^2\pi_{3p_x}^2\pi_{3p_y}^2\pi_{3p_x}^{*1}\pi_{3p_y}^{*1}$

   So, C_2 is diamagnetic.

5. Answer (3)

   Bond order of each of H_2^{2+} and He_2 is zero.

6. Answer (2)

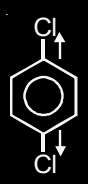
   Li_2: $\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{1s}^2$ Bond order = 1

   Li_2^+: $\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^1$ Bond order = 0.5

   Li_2^-: $\sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*1}$ Bond order = 0.5

   Li_2^- is less stable than Li_2^+ because the incoming electron goes to antibonding molecular orbital.

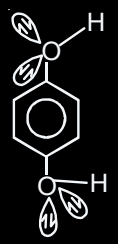
7. Answer (4)

   (a) 

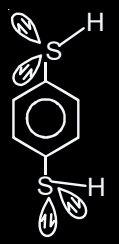
   $\mu = 0$

   (b) 

   $\mu = 0$

   (c) 

   $\mu \neq 0$

   (d) 

   $\mu \neq 0$

8. Answer (4)

Molecule/ion	Hybridization
NO_2^-	sp^2
NO_3^-	sp^2
NO_2	sp^2
NO_2^+	sp

9. Answer (4)

   CO has 14 electrons (even) $\therefore$ it is diamagnetic

   NO has $15e^-$(odd) $\therefore$ it is paramagnetic and has 1 unpaired electron in π^*2p molecular orbital.

   B_2 has $10e^-$ (even) but still paramagnetic and has two unpaired electrons in $\pi 2p_x$ and $\pi 2p_y$ (s-p mixing).

   O_2 has 16 e^- (even) but still paramagnetic and has two unpaired electrons in π^*2p_x and π^*2p_y molecular orbitals.

10. Answer (4)

	Electronic configuration	Bond order
He_2^+	$\sigma_{1s^2}\sigma_{1s^1}^*$	$\frac{2-1}{2} = 0.5$
H_2^-	$\sigma_{1s^2}\sigma_{1s^1}^*$	$\frac{2-1}{2} = 0.5$
H_2^{2-}	$\sigma_{1s^2}\sigma_{1s^2}^*$	$\frac{2-2}{2} = 0$
He_2^{2+}	σ_{1s^2}	$\frac{2-0}{2} = 1$

Molecule having zero bond order will not be a viable molecule.

11. Answer (3)

KCl – Ionic bond between K^+ and Cl^-

PH_3 – Covalent bond between P and H

O_2 – Covalent bond between O atoms

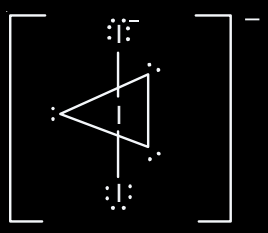
B_2H_6–Covalent bond between B and H atoms

H_2SO_4 – Covalent bond between S and O and also between O and H.

$\therefore$ Compound having no covalent bonds is KCl only.

12. Answer (3)

Structure of I_3^-



Number of lone pairs in $I_3^{\ominus}$ is 9.

13. Answer (3)

Electronic configurations of Li_2^+ and Li_2^- are

$Li_2^+ : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^1$

$Li_2^- : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^1$

Bond order of $Li_2^+ = \frac{1}{2}(3-2) = \frac{1}{2}$

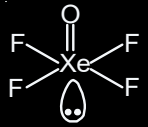
Bond order of $Li_2^- = \frac{1}{2}(4-3) = \frac{1}{2}$

Since both Li_2^+ and Li_2^- have +ve bond order, both are stable (reference : NCERT)

14. Answer (4)

N_2 Diamagnetic $\rightarrow N_2^+$	(Paramagnetic)
O_2 Paramagnetic $\rightarrow O_2^+$	(Paramagnetic)
O_2 Paramagnetic $\rightarrow O_2^{2-}$	(Diamagenetics but bond order decreases from 2 to 1)
NO (Paramagnetic $\rightarrow NO^+$ bond order 2.5)	(Diamagnetic, bond order 3)

15. Answer (3)



, sp^3d^2, Lone pair = 1

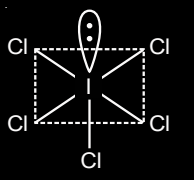
16. Answer (3)

$N_2^+ = \sigma_{1s}^2\ \sigma^*_{1s}{}^2\ \sigma_{2s}^2 \sigma^*_{2s}{}^2\ \pi_{2p_y}^2 = \pi_{2p_x}^2 \sigma_{2p_z}^1$

B.O. 2.5 = 2π bond + 0.5 σbond

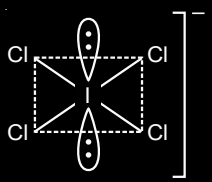
17. Answer (3)

ICl_5 is sp^3d^2 hybridised (5 bond pairs, 1 lone pair)



square pyramidal

ICl_4^- is sp^3d^2 hybridised (4 bond pairs, 2 lone pairs)



square planar

18. Answer (4)

Species	Hybridisation
ICl_2^-	sp^3d
ICl_4^-	sp^3d^2
BrF_2^-	sp^3d
IF_6^-	sp^3d^3

19. Answer (4)

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

and diamagnetic species has no unpaired electron in their molecular orbitals.

	Bond order	Magnetic character
C_2^{2-}	3	diamagnetic
N_2^{2-}	2	paramagnetic
O_2^{2-}	1	diamagnetic
O_2	2	paramagnetic

$\therefore$ C_2^{2-} has least bond length and is diamagnetic.

20. Answer (3)

C_2 has *s-p* mixing and the HOMO is $\pi 2p_x = \pi 2p_y$ and LUMO is $\sigma 2p_z$. So, the extra electron will occupy bonding molecular orbital and this will lead to an increase in bond order.

C_2^- has more bond order than C_2.

21. Answer (1)

HF has highest boiling point among the hydrogen halides due to strong H-bonding between HF molecules.

22. Answer (1)

Molecule	No. of unpaired electrons
NO	1
CO	Zero
O_2	2
B_2	2

$\therefore$ Diamagnetic species is CO.

23. Answer (2)

Electronic configuration of O_2 is

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

When O_2 gains an electron to form O_2^-, the incoming electron goes to $\pi_{2p_x}^*$ or $\pi_{2p_y}^*$

24. Answer (1)

Ionic interactions are stronger as compared to van der waal interactions.

So, correct order is

ion-ion > ion-dipole > dipole-dipole

25. Answer (2)

CN^-

Total number of electron = 14

Bond order = 3

It is diamagnetic in nature.

26. Answer (2)

The intermolecular forces present in liquid ethyl acetate are

(i) Dipole-dipole interaction

(ii) London dispersion

27. Answer (3)

$$\text{Generally, bond energy} \propto \frac{1}{\text{bond length}}$$

So bond energy order is

C–F > C–Cl > C–Br > C–I

28. Answer (1)

In case of O_2:

$$\sigma_{1s^2}\ \sigma_{1s^2}^*\ \sigma_{2s^2}\ \sigma_{2s^2}^*\ \sigma_{2P_z^2}\ \begin{matrix}\pi_{2P_x^2} & \pi_{2P_x^1}^* \\ \pi_{2P_y^2} & \pi_{2P_y^1}^*\end{matrix}\ \sigma_{2P_z^0}^*$$

Species	No. of unpaired e^-
O_2	2
O_2^-	1
O_2^+	1
O_2^{2-}	0

Magnetic moment = $\sqrt{n(n+2)}$ BM $= 1.73$ BM

$\Rightarrow$ n = no. of unpaired electrons = 1

29. Answer (3)

Compound	Shape	Hybridization	lp	Polarity
AB_4	Tetrahedral	sp^3	0	Nonpolar
AB_4	Rectangular planar	sp^3d^2	2	Nonpolar
AB_4	Square pyramidal	sp^3d	1	Polar
AB_4	Square planar	sp^3d^2	2	Nonpolar

30. Answer (3)

$CHCl_3$ is polar while CH_4 and CCl_4 are non- polar. So, dipole moment order is :

$CHCl_3 > CH_4 = CCl_4$

31. Answer (4)

$$\text{Ion-ion interaction energy} \propto \frac{1}{r}$$

$$\text{Dipole-dipole interaction energy} \propto \frac{1}{r^3}$$

$$\text{London dispersion} \propto \frac{1}{r^6}$$

[Reference — NCERT (Page-137)]

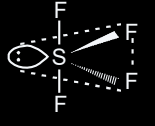
32. Answer (2)

SF_4 Bond pair = 4

Lone pair = 1

Steric Number = 5

Hybridisation $\rightarrow sp^3d$



Geometry $\rightarrow$ Triagonal bipyramidal

Shape $\rightarrow$ See saw

33. Answer (1)

$[XeF_5]^-$ is Pentagonal planar

XeO_3F_2 is trigonal Pyramidal.

34. Answer (1)

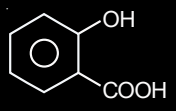
Boiling point of H_2S is 213 K.

35. Answer (1)

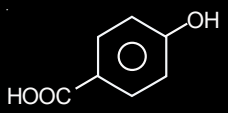
Species with minimum bond order will have minimum bond strength.

NO^- has maximum e^- in anti-bonding orbitals hence will have minimum bond strength.

36. Answer (3)

(A) 

Intramolecular hydrogen bonding is present

(B) 

Intermolecular hydrogen bonding is present

Correct order are

(B) > (A) (Boiling point)

(B) > (A) (Solubility)

Because of intermolecular hydrogen bonding.

Boiling point and solubility of (B) is more than (A).

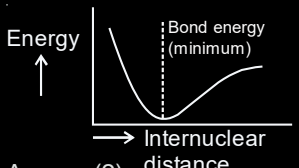
37. Answer (1)

The bond which has greater potential energy (more negative) is considered more stable as it requires more energy to dissociate.

$\because$ A–B bond has most negative potential energy hence it is strongest bond and has maximum bond enthalpy.

A–D is longest bond.

38. Answer (3)

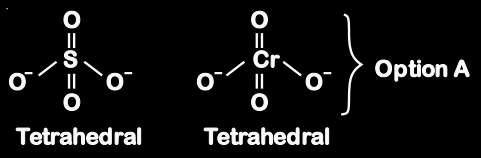


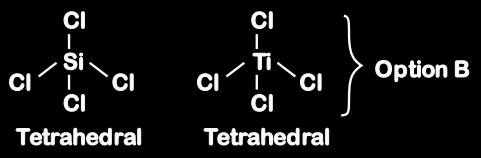
39. Answer (2)

Order of bond angle is

$CH_4 > NH_3 > H_2O > H_2S$

40. Answer (3)



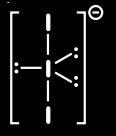


Isostructural means same structure

So option-3 is the correct answer

41. Answer (4)

I_3^-



Shape = Linear

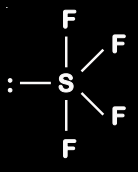
Angle $\angle I - I - I$ is 180°

42. Answer (2)

Species with bond order equal to zero will not exist.

Species	Bond order
He_2^-	0.5
Be_2	0
He_2^+	0.5
O_2^{2-}	1

43. Answer (3)

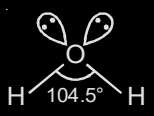


axial bonds are longer than equatorial bonds. Only SF_4 has unequal bond length.

44. Answer (4)

Molecule	Bond order
Ne_2	0
N_2	3
F_2	1
O_2	2

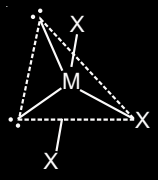
45. Answer (3)



Repulsion between lone pair - lone pair electrons is higher than bond pair - bond pair electrons. Because bond pair electrons are stuck between two nuclei.

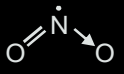
46. Answer (3)

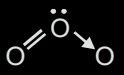
The shape of a molecule (MX_3) whose central atom (M) has two lone pairs of electrons and forms three single bonds is T-shaped.

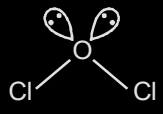


47. Answer (1)

N_3^- : $\bar{N}=\overset{+}{N}=\bar{N}$ Linear

NO_2 :  Bent

O_3 :  Bent

Cl_2O:  Bent

48. Answer (15)

Bond order

$$= \frac{\text{No. of } e^- \text{s in BMO} - \text{No. of } e^- \text{s in ABMO}}{2}$$

$\Rightarrow$ No. of e^-s in BMO – No. of e^-s in AMBO = 5

As AX is diatomic molecule (neutral)

The only possible case is CO

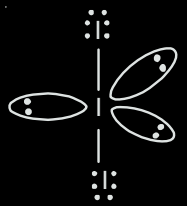
Total number of electrons = 15

Note : Total number of electrons equal to 13 will also have the 2.5 bond order. But in this case neutral diatomic molecule will not be possible.

49. Answer (2)

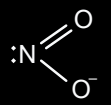
Species	**No. of lone pair of electron present on central atom**
SF_4	1
BF_4^-	0
ClF_3	2
AsF_3	1
PCl_5	0
BrF_5	1
XeF_4	2
SF_6	0

50. Answer (3)

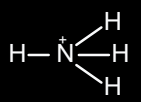
 central iodine atom has 3 lone pairs of electrons

51. Answer (3)

The type of hybridisation of atomic orbitals of nitrogen in the given species is

NO_2^- : sp^2 

NO_2^+ : sp $O=\overset{+}{N}=O$

NH_4^+ : sp^3 

52. Answer (4)

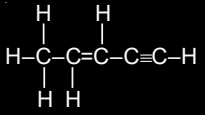
$SF_4 - sp^3d$ hybridised

$IF_5 - sp^3d^2$ hybridised

$\overset{+}{N}O_2 - sp$ hybridised

$\overset{+}{N}H_4 - sp^3$ hybridised

53. Answer (10)



$\rightarrow$ 10 sigma bonds and 3 pi bonds.

54. Answer (2)

Electronic configuration and B and order of the given species

O_2 : $\sigma_{1s}^2\sigma^{*2}_{1s}\ \sigma_{2s}^2\sigma^{*2}_{2s}\ \sigma_{2p_z}^2\pi_{2p_x}^2 = \pi_{2p_y}^2\pi^{*1}_{2p_x} = \pi^{*}_{2p_y}$

B.O. = 2

O_2^+ : $\sigma_{1s}^2\sigma^{*2}_{1s}\ \sigma_{2s}^2\sigma^{*2}_{2s}\ \sigma_{2p_z}^2\pi_{2p_x}^2 = \pi_{2p_y}^2\pi^{*1}_{2p_x}$

B.O. = 2.5

O_2^- : $\sigma_{1s}^2\sigma^{*2}_{1s}\ \sigma_{2s}^2\sigma^{*2}_{2s}\ \sigma_{2p_z}^2\pi_{2p_x}^2 = \pi_{2p_y}^2\pi^{*2}_{2p_x} = \pi^{*1}_{2p_y}$

B.O. = 1.5

O_2^{2-} : $\sigma_{1s}^2\sigma^{*2}_{1s}\ \sigma_{2s}^2\sigma^{*2}_{2s}\ \sigma_{2p_z}^2\pi_{2p_x}^2 = \pi_{2p_y}^2\pi^{*2}_{2p_x} = \pi^{*2}_{2p_y}$

B.O. = 1.0

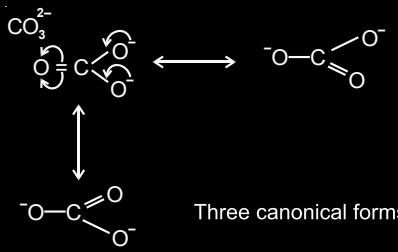
$\therefore$ Correct bond order sequence is

$O_2^+ > O_2 > O_2^- > O_2^{2-}$

55. Answer (3)

SO_2

Two canonical forms



Three canonical forms

56. Answer (00)

Bond order of CO = 3

Bond order of NO^+ = 3

Difference = 0

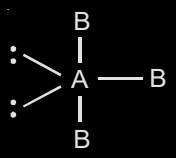
57. Answer (10)

O_2^{2-}

$\sigma1s^2\ \sigma^*1s^2\ \sigma2s^2\ \sigma^*2s^2\ \sigma2p_z{}^2\ \begin{matrix}\pi2p\pi_x^2\ \ \pi^*2p_x^2\\ \pi2p_y^2\ \ \pi^*2p_y^2\end{matrix}\ \sigma^*2p_z{}^0$

Total number of electrons in bonding molecular orbitals = 10

58. Answer (2)



T-shape

An interhalogen compound.

59. Answer (2)

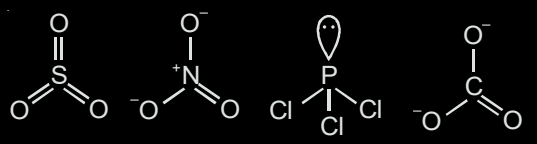
According to MOT the electronic configuration of

O_2^- ion is $\sigma1s^2\ \sigma^*1s^2\ \sigma2s^2\ \sigma^*2s^2\ \sigma2p_z^{2}\ \begin{matrix}\pi2p_x^2\ \pi^*2p_x^2\\ \pi2p_y^2\ \pi^*2p_y^1\end{matrix}$

Bond order $= \frac{1}{2}$ (Bonding electrons – anti bonding electrons)

Bond order $= \frac{1}{2}(10-7) = 1.5$

60. Answer (3)



Trigonal planar | Trigonal planar | Pyramidal | Trigonal planar

61. Answer (0)

Electronic configuration of O_2^{2-} (according to MOT) is

$\sigma1s^2,\ \sigma^*1s^2,\ \sigma2s^2,\ \sigma^*2s^2,\ \sigma2p_x^2,\ \begin{cases}\pi2p_y^2, & \begin{cases}\pi^*2p_y^2,\\ \pi^*2p_z^2\end{cases}\\ \pi2p_z^2, & \end{cases}\ \sigma^*2p_x$

Total unpaired electron in O_2^{2-} is zero.

62. Answer (3)

Oxides	**Magnetic nature**
Li_2O	Diamagnetic
CaO	Diamagnetic
Na_2O_2	Diamagnetic
KO_2	Paramagnetic
MgO	Diamagnetic
K_2O	Diamagnetic

63. Answer (173)

According to MOT, electronic configuration of B_2^+ is $\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\ \begin{matrix}\pi 2p_x^1\\ \pi 2p_y\end{matrix}\ \sigma 2p_z$. It has one unpaired electron.

(μ) Spin - only magnetic moment = $\sqrt{n(n+2)}$ B.M.

n = Number of unpaired electrons

$\mu = \sqrt{1(1+2)}$ B.M.

μ = 1.73 B.M.

$\mu = 173 \times 10^{-2}$ B.M.

64. Answer (2)

$C_2^{2-}: \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \pi_{2p_x}^2 = \pi_{2p_y}^2\ \sigma_{2p_z}^2$

$N_2^{2-}: \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 = \pi_{2p_y}^2\ \pi_{2p_x}^{*1} = \pi_{2p_y}^{*1}$

$O_2^{2-}: \sigma_{1s}^2\ \sigma_{1s}^{*2}\ \sigma_{2s}^2\ \sigma_{2s}^{*2}\ \sigma_{2p_z}^2\ \pi_{2p_x}^2 = \pi_{2p_y}^2\ \pi_{2p_x}^{*2} = \pi_{2p_y}^{*2}$

B.O. (C_2^{2-}) = 3; B.O. (N_2^{2-}) = 2; B.O. $(O_2^{2-}) = 1$

65. Answer (3)

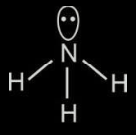
Only B_2H_6 and BCl_3 are e^- deficient among the given molecules.

66. Answer (3)

F – Be – F $\mu = 0$

$\mu = 0$

$\mu \neq 0$



$\mu \neq 0$

$\mu = 0$

H – Cl $\mu \neq 0$

67. Answer (1)

Species	Bond order
O_2^+	2.5
O_2	2
O_2^-	1.5
O_2^{-2}	1

68. Answer (2)

XeF_4 and H_2O have 2 lone pairs.

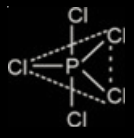
69. Answer (2)

(Shape)	(Molecules)
(A) T-shaped	(III) ClF_3
(B) Trigonal planar	(IV) BF_3
(C) Square planar	(I) XeF_4
(D) See-saw	(II) SF_4

Hence, (2) is the correct option.

70. Answer (3)

PCl_5



- All three equatorial bonds in a plane
- sp^3d hybridization
- Trigonal bipyramidal
- Axial bonds are weaker than equatorial bonds.

71. Answer (3)

Due to high difference in electronegativity of H and N the H-bond strength of NH_3 is highest. There is no H-bond in CH_4.

$CH_4 < HCN < NH_3$

Hence, correct option is (3)

72. Answer (1)

PF_5 is sp^3d hybridised

y = 1

73. Answer (1)

$SF_4 \rightarrow sp^3d$ hybridisation.

The lone pair of electrons on S is in equatorial position and there are two lone pair-bond pair repulsions at 90°.

74. Answer (3)

Covalent character $\propto$ polarising power of cation

Correct decreasing order of covalent character

LiCl > NaCl > KCl > CsCl

75. Answer (3)

BrF_3 Shape is bent T-shape

2 Lone pairs

76. Answer (2)

According to **molecular** orbital theory, the electronic configurations of the given species are

$N_2 : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$

$N_2^+ : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$

$N_2^- : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1$

$N_2^{2-} : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^1$

$O_2 : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^1$

$O_2^+ : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_1^x$

$O_2^- : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1$

$O_2^{2-} : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2$
$= \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^2$

Diamagnetic species are N_2 and O_2^{2-}

$\therefore$ Number of species showing diamagnetism = 2

77. Answer (1)

XeO_3 — sp^3, Pyramidal

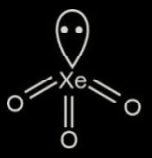
XeF_2 — sp^3d, linear

$XeOF_4$ — sp^3d^2, Square Pyramidal

XeF_6 — sp^3d^3, distorted octahedral

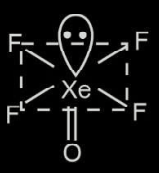
78. Answer (3)

$XeO_3 \Rightarrow$ S.N. (Steric number) = $\frac{1}{2}[8] = 4 \Rightarrow sp^3$



lone pair
on central atom = 1

$XeOF_4 \Rightarrow$ S.N = $\frac{1}{2}$ [8 + 4] = 6 $\Rightarrow sp^3d^2$



lone pair
on central atom = 1

$XeF_6 \Rightarrow$ S.N = [8 + 6] = 7 $\Rightarrow sp^3d^3$

lone pair
on central atom = 1

Sum of lone pairs = 3

79. Answer (3)

(A) BrF_5 – square pyramidal

(B) $[CrF_6]^{3-}$ – octahedral

(C) O_3 – bent

(D) PCl_5 – trigonal bipyramidal

80. Answer (2)

From Fajan's rule, for a given metal ion, as the size of anion increases, polarizability of anion increases and hence covalent character of the given ionic compound increases.

Hence, the increasing order of covalent character is

$CaF_2 < CaCl_2 < CaBr_2 < CaI_2$

81. Answer (3)

CN^-, NO^+ and O_2^{2+} have bond order of '3'

O_2 has bond order of 2,

O_2^+ has bond order of 2.5

$\therefore$ 3 species have similar bond order.

82. Answer (3)

$\Psi_A - \Psi_B = \Psi_{MO}$ is anti-bonding molecular orbital

$\mu = Q \times r$ is dipole moment

$\frac{N_b - N_a}{2}$ = bond order

$\Psi_A + \Psi_B = \Psi_{MO}$ is bonding molecular orbital.

83. Answer (06.00)

$NO_3^{\ominus}$ $\rightarrow$ Trigonal planar (Planar)

H_2O_2 $\rightarrow$ Open book (Non-planar)

BF_3 $\rightarrow$ Trigonal planar (Planar)

PCl_3 $\rightarrow$ Pyramidal (Non-planar)

XeF_4 $\rightarrow$ Square planar (Planar)

SF_4 $\rightarrow$ See-Saw (Non-planar)

XeO_3 $\rightarrow$ Pyramidal (Non-planar)

$PH_4^{\oplus}$ $\rightarrow$ Tetrahedral (Non-planar)

SO_3 $\rightarrow$ Trigonal planar (Planar)

$[Al(OH)_4]^-$ $\rightarrow$ Tetrahedral (Non-planar)

84. Answer (4)

$B_2 \rightarrow 10\ e^-$	paramagnetic
$Li_2 \rightarrow 6\ e^-$	
$C_2 \rightarrow 12\ e^-$	
$C_2^- \rightarrow 13\ e^-$	paramagnetic
$O_2^{-2} \rightarrow 18\ e^-$	
$O_2^+ \rightarrow 15\ e^-$	paramagnetic
$He_2^+ \rightarrow 3\ e^-$	paramagnetic

Species with odd number of electrons are paramagnetic except boron and oxygen.

85. Answer (1)

Zero overlapping is something in which there is no overlapping between two orbitals. The first condition is that the two orbitals should not be symmetrical and the second condition is that both orbitals should be in different planes.

86. Answer (2)

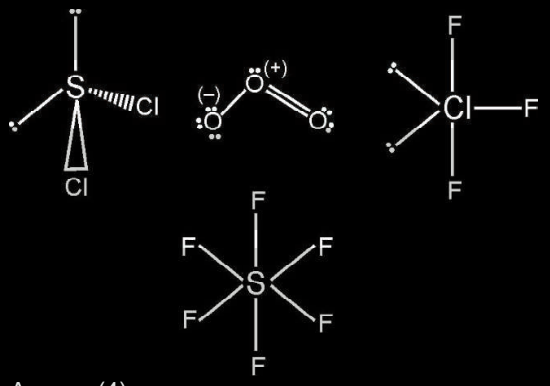
NO is an odd electron species as N has 5 valence electrons and O has 6 valence electrons. Thus overall 1 electron on N remains unpaired.

S in H_2SO_4 has an expanded octet thus H_2SO_4 is expanded octet molecule.

87. Answer (2)

The number of lone pair of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6 are 2, 1, 2 and 0 respectively

Their structures are as,



88. Answer (4)

Hybridisation of Central atom

PF_5	$\longrightarrow$	sp^3d
BrF_5	$\longrightarrow$	sp^3d^2
PCl_3	$\longrightarrow$	sp^3
SF_6	$\longrightarrow$	sp^3d^2
ICl_4^{Θ}	$\longrightarrow$	sp^3d^2
ClF_3	$\longrightarrow$	sp^3d
IF_5	$\longrightarrow$	sp^3d^2

89. Answer (2)

CH_4, NH_4^+ and BH_4^- are isoelectronic as well as tetrahedral.

90. Answer (3)

If an electron is removed from the anti-bonding orbital, then it will tend to increase the bond order.

The HOMO in NO and O_2 is antibonding molecular orbital .

Hence, in NO and O_2 bond order will increase on loss of electron.