CHAPTER

4

Chemical Bonding and Molecular Structure

Section-A JEE Advanced/ IIT-JEE

A Fill in the Blanks

1. The angle between two covalent bonds is maximum in ..... . (CH_4, H_2O, CO_2) *(1981 - 1 Mark)*
2. Pair of molecules which forms strongest intermolecular hydrogen bond is ..... .

   (SiH_4 and SiF_4, $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ and $CHCl_3$, $H-\overset{\overset{O}{\|}}{C}-OH$ and $CH_3-\overset{\overset{O}{\|}}{C}-OH$) *(1981 - 1 Mark)*
3. There are ..... π bonds in a nitrogen molecule. *(1982 - 1 Mark)*
4. ..... hybrid orbitals of nitrogen atom are involved in the formation of ammonium ion. *(1982 - 1 Mark)*
5. The shape of $[CH_3]^+$ is ..... . *(1990 - 1 Mark)*
6. The two types of bonds present in B_2H_6 are covalent and ..... *(1994 - 1 Mark)*
7. When N_2 goes to N_2^+, the N–N bond distance ..., and when O_2 goes to O_2^+ the O–O bond distance.... *(1996 - 1 Mark)*

B True / False

1. Linear overlap of two atomic p-orbitals leads to a sigma bond. *(1983 - 1 Mark)*
2. All molecules with polar bonds have dipole moment. *(1985 - ½ Mark)*
3. $SnCl_2$ is a non-linear molecule. *(1985 - ½ Mark)*
4. In benzene, carbon uses all the three p-orbitals for hybridisation. *(1987 - 1 Mark)*
5. sp^2 hybrid orbitals have equal *s* and *p* character. *(1987 - 1 Mark)*
6. The presence of polar bonds in a poly-atomic molecule suggests that the molecule has non-zero dipole moment. *(1990 - 1 Mark)*
7. The dipole moment of CH_3F is greater than that of CH_3Cl. *(1993 - 1 Mark)*

C MCQs with One Correct Answer

1. The compound which contains both ionic and covalent bonds is *(1979)*
   (a) CH_4 (b) H_2 (c) KCN (d) KCl
2. The octet rule is not valid for the molecule *(1979)*
   (a) CO_2 (b) H_2O (c) O_2 (d) CO
3. Element X is strongly electropositive and element Y is strongly electronegative. Both are univalent. The compound formed would be *(1980)*
   (a) X^+Y^- (b) X^-X^+ (c) X–Y (d) $X \rightarrow Y$
4. Which of the following compounds are covalent? *(1980)*
   (a) H_2 (b) CaO (c) KCl (d) Na_2S
5. The total number of electrons that take part in forming the bond in N_2 is *(1980)*
   (a) 2 (b) 4 (c) 6 (d) 10
6. Which of the following is soluble in water *(1980)*
   (a) CS_2 (b) C_2H_5OH
   (c) CCl_4 (d) $CHCl_3$
7. If a molecule MX_3 has zero dipole moment, the sigma bonding orbitals used by M (atomic number < 21) are *(1981 - 1 Mark)*
   (a) pure *p* (b) *sp* hybrid
   (c) sp^2 hybrid (d) sp^3 hybrid
8. The ion that is isoelectronic with CO is *(1982 - 1 Mark)*
   (a) CN^- (b) O_2^+ (c) O_2^- (d) N_2^+
9. Among the following, the molecule that is linear is
   (a) CO_2 (b) NO_2 *(1982 - 1 Mark)*
   (c) SO_2 (d) ClO_2
10. The compound with no dipole moment is *(1982 - 1 Mark)*
    (a) methyl chloride (b) carbon tetrachloride
    (c) methylene chloride (d) chloroform
11. Carbon tetrachloride has no net dipole moment because of
    (a) its planar structure *(1983 - 1 Mark)*
    (b) its regular tetrahedral structure
    (c) similar sizes of carbon and chlorine
    (d) similar electron affinities of carbon and chlorine
12. Which one among the following does not have the hydrogen bond? *(1983 - 1 Mark)*
    (a) phenol (b) liquid NH_3
    (c) water (d) liquid HCl
13. The types of bonds present in $CuSO_4.5H_2O$ are only
    (a) electrovalent and covalent *(1983 - 1 Mark)*
    (b) electrovalent and coordinate covalent
    (c) electrovalent, covalent and coordinate covalent
    (d) covalent and coordinate covalent

14. On hybridization of one *s* and one *p* orbitals we get : *(1984 - 1 Mark)*
(a) two mutually perpendicular orbitals
(b) two orbitals at 180°
(c) four orbitals directed tetrahedrally
(d) three orbitals in a plane

15. The molecule having one unpaired electron is : *(1985 - 1 Mark)*
(a) NO (b) CO (c) CN^- (d) O_2

16. The bond between two identical non-metal atoms has a pair of electrons : *(1986 - 1 Mark)*
(a) unequally shared between the two
(b) transferred fully from one atom to another
(c) with identical spins
(d) equally shared between them

17. The hydrogen bond is strongest in : *(1986 - 1 Mark)*
(a) O–H.....S (b) S–H.....O
(c) F–H.....F (d) F–H.....O

18. The hybridisation of sulphur in sulphur dioxide is : *(1986 - 1 Mark)*
(a) *sp* (b) sp^3 (c) sp^2 (d) dsp^2

19. Hydrogen bonding is maximum in *(1987 - 1 Mark)*
(a) Ethanol (b) Diethyl ether
(c) Ethyl chloride (d) Triethylamine

20. The species in which the central atom uses sp^2 hybrid orbitals in its bonding is *(1988 - 1 Mark)*
(a) PH_3 (b) NH_3 (c) CH_3^+ (d) SbH_3

21. The molecule that has linear structure is *(1988 - 1 Mark)*
(a) CO_2 (b) NO_2 (c) SO_2 (d) SiO_2

22. The molecule which has zero dipole moment is :
(a) CH_2Cl_2 (b) BF_3 *(1989 - 1 Mark)*
(c) NF_3 (d) ClO_2

23. The molecule which has pyramidal shape is :
(a) PCl_3 (b) SO_3 *(1989 - 1 Mark)*
(c) CO_3^{2-} (d) NO_3^-

24. The compound in which $\overset{*}{C}$ uses its sp^3 hybrid orbitals for bond formation is : *(1989 - 1 Mark)*
(a) $H\overset{*}{C}OOH$ (b) $(H_2N)_2\overset{*}{C}O$
(c) $(CH_3)_3\overset{*}{C}OH$ (d) $CH_3\overset{*}{C}HO$

25. Which of the following is paramagnetic? *(1989 - 1 Mark)*
(a) O_2^- (b) CN^- (c) CO (d) NO^+

26. The type of hybrid orbitals used by the chlorine atom in ClO_2^- is *(1992 - 1 Mark)*
(a) sp^3 (b) sp^2
(c) sp (d) none of these

27. The maximum possible number of hydrogen bonds a water molecule can form is *(1992 - 1 Mark)*
(a) 2 (b) 4 (c) 3 (d) 1

28. The cyanide ion, CN^- and N_2 are isoelectronic. But in contrast to CN^-, N_2 is chemically inert, because of *(1992 - 1 Mark)*
(a) low bond energy
(b) absence of bond polarity
(c) unsymmetrical electron distribution
(d) presence of more number of electrons in bonding orbitals

29. Pick out the isoelectronic structures from the following; *(1993 - 1 Mark)*
I. CH_3^+ II. H_3O^+
III. NH_3 IV CH_3^-
(a) I and II (b) III and IV
(c) I and III (d) II, III and IV

30. Which one is most ionic : *(1995S)*
(a) P_2O_5 (b) CrO_3 (c) MnO (d) Mn_2O_7

31. Number of paired electrons in O_2 molecule is : *(1995S)*
(a) 7 (b) 8 (c) 16 (d) 14

32. Among the following species, identify the isostructural pairs.
NF_3, NO_3^-, BF_3, H_3O^+, HN_3 *(1996 - 1 Mark)*
(a) $[NF_3, NO_3^-]$ and $[BF_3, H_3O^+]$
(b) $[NF_3, HN_3]$ and $[NO_3^-, BF_3]$
(c) $[NF_3, H_3O^+]$ and $[NO_3^-, BF_3]$
(d) $[NF_3, H_3O^+]$ and $[HN_3, BF_3]$

33. The number and type of bonds between two carbon atoms in CaC_2 are : *(1996 - 1 Mark)*
(a) one sigma (σ) and one pi (π) bonds
(b) one sigma (σ) and two pi (π) bonds
(c) one sigma (σ) and one and a half pi (π) bonds
(d) one sigma (σ) bond.

34. Which contains both polar and non-polar bonds?
(a) NH_4Cl (b) HCN *(1997 - 1 Mark)*
(c) H_2O_2 (d) CH_4

35. The critical temperature of water is higher than that of O_2 because the H_2O molecule has *(1997 - 1 Mark)*
(a) fewer electrons than O_2
(b) two covalent bonds
(c) V-shape (d) dipole moment.

36. Which one of the following compounds has sp^2 hydridization? *(1997 - 1 Mark)*
(a) CO_2 (b) SO_2 (c) N_2O (d) CO

37. The geometry and the type of hybrid orbital present about the central atom in BF_3 is *(1998 - 2 Marks)*
(a) linear, sp (b) trigonal planar, sp^2
(c) tetrahedral, sp^3 (d) pyramidal, sp^3.

38. The correct order of increasing C — O bond length of CO, CO_3^{2-}, CO_2, is *(1999 - 2 Marks)*
(a) $CO_3^{2-} < CO_2 < CO$ (b) $CO_2 < CO_3^{2-} < CO$
(c) $CO < CO_3^{2-} < CO_2$ (d) $CO < CO_2 < CO_3^{2-}$

39. The geometry of H_2S and its dipole moment are *(1999 - 2 Marks)*
(a) angular and non-zero (b) angular and zero
(c) linear and non-zero (d) linear and zero

40. Molecular shapes of SF_4, CF_4 and XeF_4 are *(2000S)*
(a) the same, with 2, 0 and 1 lone pairs of electrons respectively
(b) the same, with 1, 1 and 1 lone pairs of electrons respectively
(c) different, with 0, 1 and 2 lone pairs of electrons respectively
(d) different, with 1, 0 and 2 lone pairs of electrons respectively

41. The hybridisation of atomic orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ are *(2000S)*
(a) sp, sp^3 and sp^2 respectively
(b) sp, sp^2 and sp^3 respectively
(c) sp^2, sp and sp^3 respectively
(d) sp^2, sp^3 and sp respectively

42. The common features among the species CN^-, CO and NO^+ are *(2001S)*
(a) bond order three and isoelectronic
(b) bond order three and weak field ligands
(c) bond order two and π–acceptors
(d) isoelectronic and weak field ligands

43. The correct order of hybridization of the central atom in the following species NH_3, $[PtCl_4]^{2-}$, PCl_5 and BCl_3 is *(2001S)*
(a) dsp^2, dsp^3, sp^2 and sp^3 (b) sp^3, dsp^2, dsp^3, sp^2
(c) dsp^2, sp^2, sp^3, dsp^3 (d) dsp^2, sp^3, sp^2, dsp^3

44. Specify the coordination geometry around and hybridisation of N and B atoms in a 1 : 1 complex of BF_3 and NH_3
(a) N : tetrahedral, sp^3; B : tetrahedral, sp^3 *(2002S)*
(b) N : pyramidal, sp^3; B : pyramidal, sp^3
(c) N : pyramidal, sp^3; B : planar, sp^2
(d) N : pyramidal, sp^3; B : tetrahedral, sp^3

45. Identify the least stable ion amongst the following : *(2002S)*
(a) Li^- (b) Be^- (c) B^- (d) C^-

46. Which of the following molecular species has unpaired electron(s) ? *(2002S)*
(a) N_2 (b) F_2 (c) O_2^- (d) O_2^{2-}

47. Which of the following are isoelectronic and isostructural? NO_3^-, CO_3^{2-}, ClO_3^-, SO_3 *(2003S)*
(a) NO_3^-, CO_3^{2-} (b) SO_3, NO_3^-
(c) ClO_3^-, CO_3^{2-} (d) CO_3^{2-}, SO_3

48. According to molecular orbital theory which of the following statement about the magnetic character and bond order is correct regarding O_2^+ *(2004S)*
(a) Paramagnetic and Bond order < O_2
(b) Paramagnetic and Bond order > O_2
(c) Diamagnetic and Bond order < O_2
(d) Diamagnetic and Bond order > O_2

49. Which species has the maximum number of lone pair of electrons on the central atom? *(2005S)*
(a) $[ClO_3]^-$ (b) XeF_4 (c) SF_4 (d) $[I_3]^-$

50. Among the following, the paramagnetic compound is *(2007)*
(a) Na_2O_2 (b) O_3 (c) N_2O (d) KO_2

51. The species having bond order different from that in CO is *(2007)*
(a) NO^- (b) NO^+ (c) CN^- (d) N_2

52. Assuming that Hund's rule is violated, the bond order and magnetic nature of the diatomic molecule B_2 is *(2010)*
(a) 1 and diamagnetic (b) 0 and dimagnetic
(c) 1 and paramagnetic (d) 0 and paramagnetic

53. The species having pyramidal shape is : *(2010)*
(a) SO_3 (b) BrF_3 (c) SiO_3^{2-} (d) OSF_2

54. Geometrical shapes of the complexes formed by the reaction of Ni^{2+} with Cl^-, CN^- and H_2O, respectively, are *(2011)*
(a) octahedral, tetrahedral and square planar
(b) tetrahedral, square planar and octahedral
(c) square planar, tetrahedral and octahedral
(d) octahedral, square planar and octahedral

55. Assuming 2*s*-2*p* mixing is **NOT** operative, the paramagnetic species among the following is *(JEE Adv. 2014)*
(a) Be_2 (b) B_2 (c) C_2 (d) N_2

56. The geometries of the ammonia complexes of Ni^{2+}, Pt^{2+} and Zn^{2+} respectively, are *(JEE Adv. 2016)*
(a) octahedral, square planar and tetrahedral
(b) square planar, octahedral and tetrahedral
(c) tetrahedral, square planar and octahedral
(d) octahedral, tetrahedral and square planar

D MCQs with One or More Than One Correct

1. CO_2 is isostructural with : *(1986 - 1 Mark)*
(a) $HgCl_2$ (b) $SnCl_2$ (c) C_2H_2 (d) NO_2

2. The linear structure is assumed by : *(1991 - 1 Mark)*
(a) $SnCl_2$ (b) NCO^- (c) CS_2 (d) NO_2^+

3. Which of the following have identical bond order? *(1992 - 1 Mark)*
(a) CN^- (b) O_2^- (c) NO^+ (d) CN^+

4. The molecules that will have dipole moment are *(1992 - 1 Mark)*
(a) 2, 2-dimethylpropane (b) trans-2-pentene
(c) cis-3-hexene (d) 2,2,3,3-tetramethylbutane

5. The compound(s) with TWO lone pairs of electrons on the central atom is(are) *(JEE Adv. 2016)*
(a) BrF_5 (b) ClF_3 (c) XeF_4 (d) SF_4

6. According to Molecular Orbital Theory, *(JEE Adv. 2016)*
(a) C_2^{2-} is expected to be diamagnetic
(b) O_2^{2+} is expected to have a longer bond length than O_2
(c) N_2^+ and N_2^- have the same bond order
(d) He_2^+ has the same energy as two isolated He atoms

E Subjective Problems

1. Water is liquid while H_2S is a gas at room temperature. *(1978)*

2. Write the Lewis dot structural formula for each of the following. Give, also, the formula of a neutral molecule, which has the same geometry and the same arrangement of the bonding electrons as in each of the following. An example is

given below in the case of H_3O^+ :

Lewis dot structure | Neutral molecule

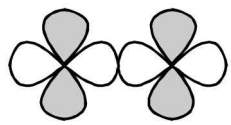
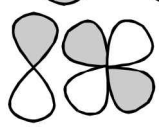
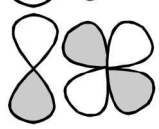
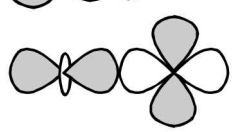
(i) O_2^{2-} ; (ii) CO_3^{2-} ; (iii) CN^-; (iv) NCS^-

(1983 - 1 × 4 = 4 Marks)

3. How many sigma bonds and how many pi-bonds are present in a benzene molecule? *(1985 - 1 Mark)*
4. Write the Lewis dot structure of the following :
   $O_3, COCl_2$
   (1986 - 1 Mark)
5. Arrange the following :
   (i) N_2, O_2, F_2, Cl_2 in increasing order of bond dissociation energy. *(1988 - 1 Mark)*
   (ii) Increasing strength of hydrogen bonding (X–H–X) : *(1991 - 1 Mark)*
   O, S, F, Cl, N
   (iii) In the decreasing order of the O – O bond length present in them *(2004 - 4 Marks)*
   O_2, KO_2 and $O_2[AsF_4]$
6. The dipole moment of KCl is 3.336×10^{-29} Coulomb meters which indicates that it is a highly polar molecule. The interatomic distance between K^+ and Cl^- in this molecule is 2.6×10^{-10} m. Calculate the dipole moment of KCl molecule if there were opposite charges of one fundamental unit located at each nucleus. Calculate the percentage ionic character of KCl. *(1993 - 2 Marks)*
7. Using the VSEPR theory, identify the type of hybridization and draw the structure of OF_2. What are the oxidation states of O and F ? *(1994 - 3 Marks)*
8. A compound of vanadium has a magnetic moment of 1.73 BM. Work out the electronic configuration of the vanadium ion in the compound. *(1997 - 2 Marks)*
9. Interpret the non-linear shape of H_2S molecule and non-planar shape of PCl_3 using valence shell electron pair repulsion (VSEPR) theory. (Atomic numbers : H = 1, P = 15, S = 16, Cl = 17.) *(1998 - 4 Marks)*
10. Write the M.O. electron distribution of O_2. Specify its bond order and magnetic property. *(2000 - 3 Marks)*
11. Using VSEPR theory, draw the shape of PCl_5 and BrF_5. *(2003 - 2 Marks)*
12. Draw the structure of XeF_4 and OSF_4 according to VSEPR theory, clearly indicating the state of hybridisation of the central atom and lone pair of electrons (if any) on the central atom. *(2004 - 2 Marks)*

F Match the Following

1. Match the orbital overlap figures shown in List-I with the description given in List-II and select the correct answer using the code given below the lists. *(JEE Adv. 2014)*

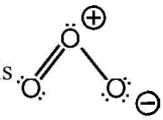
List-I		List-II
P.		1. $p-d\,\pi$ antibonding
Q.		2. $d-d\,\sigma$ bonding
R.		3. $p-d\,\pi$ bonding
S.		4. $d-d\,\sigma$ antibonding

Code:

	P	Q	R	S
(a)	2	1	3	4
(b)	4	3	1	2
(c)	2	3	1	4
(d)	4	1	3	2

H Assertion & Reason Type Questions

1. Read the following Assertion and Reason and answer as per the options given below : *(1998 - 2 Marks)*

Assertion : The electronic structure of O_3 is 

Reason :  structure is not allowed because octet around O cannot be expanded.

(a) If both *assertion* and *reason* are correct, and *reason* is the correct explanation of the *assertion*.
(b) If both *assertion* and *reason* are correct, but *reason* is not the correct explanation of the *assertion*.
(c) If *assertion* is correct but *reason* is incorrect.
(d) If *assertion* is incorrect but *reason* is correct.

2. Read the following Assertion and Reason and answer as per the options given below : *(1998 - 2 Marks)*
Assertion : LiCl is predominantly a covalent compound.
Reason : Electronegativity difference between Li and Cl is too small.
(a) If both *assertion* and *reason* are correct, and *reason* is the correct explanation of the *assertion*.
(b) If both *assertion* and *reason* are correct, but *reason* is not the correct explanation of the *assertion*.
(c) If *assertion* is correct but *reason* is incorrect.
(d) If *assertion* is incorrect but *reason* is correct.

I Integer Value Correct Type

1. Based on VSEPR theory, the number of 90 degree F–Br–F angles in BrF_5 is *(2010)*
2. The total number of lone-pairs of electrons in melamine is *(JEE Adv. 2013)*

3. A list of species having the formula XZ_4 is given below.
XeF_4, SF_4, SiF_4, BF_4^-, BrF_4^-, $[Cu(NH_3)_4]^{2+}$, $[FeCl_4]^{2-}$, $[CoCl_4]^{2-}$ and $[PtCl_4]^{2-}$.
Defining shape on the basis of the location of X and Z atoms, the total number of species having a square planar shape is
(JEE Adv. 2014)

4. Among the triatomic molecules/ions, $BeCl_2$, N_3^-, N_2O, NO_2^+, O_3, SCl_2, ICl_2^-, I_3^- and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the d-orbital(s) is
[Atomic number : S = 16, Cl = 17, I = 53 and Xe = 54]
(JEE Adv. 2015)

Section-B JEE Main / AIEEE

1. In which of the following species the interatomic bond angle is 109° 28'? **[2002]**
(a) $NH_3, (BF_4)^{-1}$ (b) $(NH_4)^+, BF_3$
(c) NH_3, BF_4 (d) $(NH_2)^{-1}, BF_3$.

2. Which of the following are arranged in an increasing order of their bond strengths? **[2002]**
(a) $O_2^- < O_2 < O_2^+ < O_2^{2-}$ (b) $O_2^{2-} < O_2^- < O_2 < O_2^+$
(c) $O_2^- < O_2^{2-} < O_2 < O_2^+$ (d) $O_2^+ < O_2 < O_2^- < O_2^{2-}$

3. Hybridisation of the underline atom changes in: **[2002]**
(a) $\underline{Al}H_3$ changes to AlH_4^-
(b) $H_2\underline{O}$ changes to H_3O^+
(c) $\underline{N}H_3$ changes to NH_4^+
(d) in all cases

4. An ether is more volatile than an alcohol having the same molecular formula. This is due to **[2003]**
(a) alcohols having resonance structures
(b) inter-molecular hydrogen bonding in ethers
(c) inter-molecular hydrogen bonding in alcohols
(d) dipolar character of ethers

5. Which one of the following pairs of molecules will have permanent dipole moments for both members ? **[2003]**
(a) NO_2 and CO_2 (b) NO_2 and O_3
(c) SiF_4 and CO_2 (d) SiF_4 and NO_2

6. Which one of the following compounds has the smallest bond angle in its molecule ? **[2003]**
(a) OH_2 (b) SH_2 (c) NH_3 (d) SO_2

7. The pair of species having identical shapes for molecules of both species is **[2003]**
(a) XeF_2, CO_2 (b) BF_3, PCl_3
(c) PF_5, IF_5 (d) CF_4, SF_4

8. The correct order of bond angles (smallest first) in H_2S, NH_3, BF_3 and SiH_4 is **[2004]**
(a) $H_2S < NH_3 < SiH_4 < BF_3$ (b) $NH_3 < H_2S < SiH_4 < BF_3$
(c) $H_2S < SiH_4 < NH_3 < BF_3$ (d) $H_2S < NH_3 < BF_3 < SiH_4$

9. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species ? **[2004]**
(a) Bond length in NO^+ is equal to that in NO
(b) Bond length in NO is greater than in NO^+
(c) Bond length in NO^+ is greater than in NO
(d) Bond length is unpredictable

10. The states of hybridization of boron and oxygen atoms in boric acid (H_3BO_3) are respectively **[2004]**
(a) sp^3 and sp^2 (b) sp^2 and sp^3
(c) sp^2 and sp^2 (d) sp^3 and sp^3

11. Which one of the following has the regular tetrahedral structure ? **[2004]**
(a) BF_4^- (b) SF_4
(c) XeF_4 (d) $[Ni(CN)_4]^{2-}$
(Atomic nos. : B = 5, S = 16, Ni = 28, Xe = 54)

12. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in **[2004]**
(a) dsp^2 hybridization
(b) sp^3d hybridization
(c) dsp^3 hybridization
(d) sp^3d^2 hybridization

13. Lattice energy of an ionic compound depends upon
(a) Charge on the ion and size of the ion **[2005]**
(b) Packing of ions only
(c) Size of the ion only
(d) Charge on the ion only

14. Which of the following molecules/ions does not contain unpaired electrons? **[2006]**
(a) N_2^+ (b) O_2 (c) O_2^{2-} (d) B_2

15. In which of the following molecules/ions are all the bonds **not** equal? **[2006]**
(a) XeF_4 (b) BF_4^-
(c) SF_4 (d) SiF_4

16. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down group-15 of the periodic table is due to **[2006]**
(a) decreasing lp-bp repulsion
(b) decreasing electronegativity
(c) increasing bp-bp repulsion
(d) increasing p-orbital character in sp^3

17. Which of the following species exhibits the diamagnetic behaviour ? **[2007]**
(a) NO (b) O_2^{2-}
(c) O_2^+ (d) O_2.

18. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic

species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}? [2007]

(a) $Ca^{2+} < Mg^{2+} < Be^{+} < K^{+}$
(b) $Mg^{2+} < Be^{2+} < K^{+} < Ca^{2+}$
(c) $Be^{2+} < K^{+} < Ca^{2+} < Mg^{2+}$
(d) $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$.

19. In which of the following ionization processes, the bond order has increased and the magnetic behaviour has changed? [2007]

(a) $N_2 \rightarrow N_2^+$ (b) $C_2 \rightarrow C_2^+$
(c) $NO \rightarrow NO^+$ (d) $O_2 \rightarrow O_2^+$.

20. Which of the following hydrogen bonds is the strongest? [2007]

(a) O – H - - - F (b) O – H - - - H
(c) F – H - - - F (d) O – H - - - O.

21. Which one of the following pairs of species have the same bond order? [2008]

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

22. The bond dissociation energy of B – F in BF_3 is 646 kJ mol^{-1} whereas that of C – F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B – F bond dissociation energy as compared to that of C – F is [2008]

(a) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4.
(b) significant pπ – pπ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4.
(c) lower degree of pπ – pπ interaction between B and F in BF_3 than that between C and F in CF_4.
(d) smaller size of B– atom as compared to that of C– atom.

23. Using MO theory, predict which of the following species has the shortest bond length? [2008]

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

24. Among the following the maximum covalent character is shown by the compound [2011]

(a) $FeCl_2$ (b) $SnCl_2$ (c) $AlCl_3$ (d) $MgCl_2$

25. The hybridization of orbitals of N atom in NO_3^-, NO_2^+ and NH_4^+ are respectively : [2011]

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

26. The structure of IF_7 is [2011]

(a) square pyramidal (b) trigonal bipyramidal
(c) octahedral (d) pentagonal bipyramidal

27. Ortho-Nitrophenol is less soluble in water than *p*- and *m*-Nitrophenols because : [2012]

(a) *o*-Nitrophenol is more volatile steam than those of *m*- and *p*-isomers.
(b) *o*-Nitrophenol shows intramolecular H-bonding
(c) *o*-Nitrophenol shows intermolecular H-bonding
(d) Melting point of *o*-Nitrophenol is lower than those of *m*- and *p*-isomers.

28. In which of the following pairs the two species are not isostructural ? [2012]

(a) CO_3^{2-} and NO_3^- (b) PCl_4^+ and $SiCl_4$
(c) PF_5 and BrF_5 (d) AlF_6^{3-} and SF_6

29. Which one of the following molecules is expected to exhibit diamagnetic behaviour ? [JEE M 2013]

(a) C_2 (b) N_2
(c) O_2 (d) S_2

30. Which of the following is the wrong statement ? [JEE M 2013]

(a) ONCl and ONO^- are not isoelectronic.
(b) O_3 molecule is bent
(c) Ozone is violet-black in solid state
(d) Ozone is diamagnetic gas.

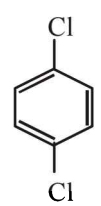
31. In which of the following pairs of molecules/ions, both the species are not likely to exist ? [JEE M 2013]

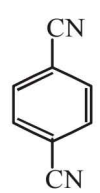
(a) H_2^+, He_2^{2-} (b) H_2^-, He_2^{2-}
(c) H_2^{2+}, He_2 (d) H_2^-, He_2^{2+}

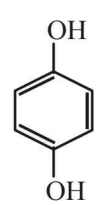
32. Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of : [JEE M 2013]

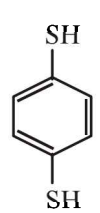
(a) $Li_2 < Li_2^+ < Li_2^-$ (b) $Li_2^- < Li_2^+ < Li_2$
(c) $Li_2 < Li_2^- < Li_2^+$ (d) $Li_2^- < Li_2 < Li_2^+$

33. For which of the following molecule significant $\mu \neq 0$? [JEE M 2014]

(i) 

(ii) 

(iii) 

(iv) 

(a) Only (i) (b) (i) and (ii)
(c) Only (iii) (d) (iii) and (iv)

34. The species in which the N atom is in a state of *sp* hybridization is : [JEE M 2016]

(a) NO_3^- (b) NO_2
(c) NO_2^+ (d) NO_2^-