4 Chemical Bonding and Molecular Structure

Conceptual MCQs

1. The compound which contains both ionic and covalent bond :
(a) KCl (b) KCN (c) CH_4 (d) H_2

2. In the following, which substance will have highest boiling point
(a) He (b) CsF (c) NH_3 (d) $CHCl_3$

3. Point out incorrect statement about resonance.
(a) Resonance structures should have equal energy.
(b) In resonance structures, the constituent atoms should be in the same position.
(c) In resonance structures, there should not be the same number of electron pairs.
(d) Resonance structures should differ only in the location of electrons around the constituent atoms.

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

5. Polarisibility of halide ions increases in the order
(a) F^-, I^-, Br^-, Cl^- (b) Cl^-, Br^-, I^-, F^-
(c) I^-, Br^-, Cl^-, F^- (d) F^-, Cl^-, Br^-, I^-

6. The dipole moment of chlorobenzene is 1.73 D. The dipole moment of *p*-dichlorobenzene is expected to be
(a) 3.46 D (b) 0.00 D
(c) 1.73 D (d) 1.00 D

7. The angle between the overlapping of one *s*-orbital and one *p*-orbital is
(a) 180° (b) 120° (c) 109°28' (d) 120° 60'

8. Equilateral shape has
(a) *sp* hybridization (b) sp^2 hybridization
(c) sp^3 hybridization (d) None of these

9. In an octahedral structure, the pair of *d* orbitals involved in d^2sp^3 hybridization is
(a) $d_{x^2-y^2}, d_{z^2}$ (b) $d_{xz}, d_{x^2-y^2}$
(c) d_{z^2}, d_{xz} (d) d_{xy}, d_{yz}

10. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down the group-15 of the periodic table is due to
(a) decrease in lp-bp repulsion
(b) decrease in electronegativity
(c) increase in bp-bp repulsion
(d) increase in lp-bp repulsion

11. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in
(a) dsp^2 hybridisation (b) sp^3d hybridisation
(c) dsp^3 hybridisation (d) sp^3d^2 hybridisation

12. The trigonal bipyramidal geometry is obtained from the hybridization :
(a) dsp^3 or sp^3d (b) dsp^2 or sp^2d
(c) d^2sp^3 or sp^3d^2 (d) None of these

13. The compound 1, 2 - butadiene has
(a) only *sp* hybridised carbon atoms
(b) only sp^2 hybridised carbon atoms
(c) both *sp* and sp^2 hybridised carbon atoms
(d) *sp*, sp^2 and sp^3 hybridised carbon atoms

14. As the *p*-character increases, the bond angle in hybrid orbitals formed by *s* and *p* atomic orbitals
(a) Decreases (b) Increases
(c) Doubles (d) Remains unchanged

15. Main axis of a diatomic molecule is z, molecular orbital p_x and p_y overlap to form which of the following orbital?
(a) π - molecular orbital (b) σ - molecular orbital
(c) δ - molecular orbital (d) No bond will be formed

16. Which is false statement about LCAO?
(a) Addition of atomic orbitals result in molecular orbitals.
(b) Atomic orbitals of nearly same energy combine to form molecular orbitals.
(c) Bonding molecular orbitals occupy higher energy than antibonding molecular orbitals.
(d) Each molecular orbital accommodates maximum no. of two electrons.

17. The conditions for the combination of atomic orbitals to form molecular orbitals are stated below. Mark the incorrect condition mentioned here.
(a) The combining atomic orbitals must have nearly same energy.
(b) The combining atomic orbitals must overlap to maximum extent.

(c) Combining atomic orbitals must have same symmetry about the molecular axis.
(d) Pi (π) molecular orbitals are symmetrical around the bond axis.

18. Total number of lone pair of electrons in I_3^- ion is :
(a) 3 (b) 6 (c) 9 (d) 12

19. The boiling point of *p*-nitrophenol is higher than that of *o*-nitrophenol because
(a) NO_2 group at *p*-position behave in a different way from that at *o*-position.
(b) intramolecular hydrogen bonding exists in *p*-nitrophenol
(c) there is intermolecular hydrogen bonding in *p*-nitrophenol
(d) *p*-nitrophenol has a higher molecular weight than *o*-nitrophenol.

20. The BCl_3 is a planar molecule whereas NCl_3 is pyramidal because
(a) B-Cl bond is more polar than N-Cl bond
(b) N-Cl bond is more covalent than B-Cl bond
(c) nitrogen atom is smaller than boron atom
(d) BCl_3 has no lone pair but NCl_3 has a lone pair of electrons

Application Based MCQs

21. An atom of an element A has three electrons in its outer shell and B has six electrons in its outermost shell. The formula of the compound formed between these two will be –
(a) A_6B_6 (b) A_2B_3 (c) A_3B_2 (d) A_2B

22. In which solvent NaCl has maximum solubility?
(a) H_2O (b) C_2H_5OH
(c) CH_3COCH_3 (d) $C_2H_5OC_2H_5$

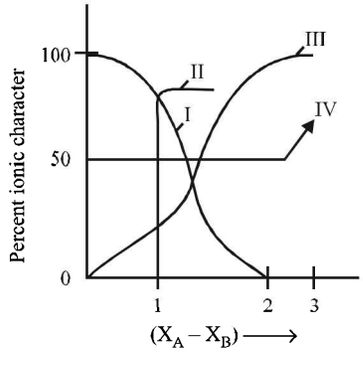
23. For two ionic solids, CaO and KI, identify the wrong statement amongst the following :
(a) The lattice energy of CaO is much large than that of KI.
(b) KI is more soluble in water.
(c) KI has higher melting point.
(d) CaO has higher melting point.

24. Among the species : CO_2, CH_3COO^-, CO, CO_3^{2-}, HCHO which has the weakest carbon-oxygen bond?
(a) CO_2 (b) CH_3COO^- (c) CO (d) CO_3^{2-}

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

26. The dipole moment of *o*, *p* and *m*-dichlorobenzene will be in the order
(a) $o > p > m$ (b) $p > o > m$
(c) $m > o > p$ (d) $o > m > p$

27. For AB bond if percent ionic character is plotted against electronegativity difference ($X_A - X_B$), the shape of the curve would look like



The correct curve is
(a) (I) (b) (II) (c) (III) (d) (IV)

28. In which one of the following molecules the central atom said to adopt sp^2 hybridization?
(a) BeF_2 (b) BF_3 (c) C_2H_2 (d) NH_3

29. Which one of the following compounds has the smallest bond angle in its molecule ?
(a) H_2O (b) H_2S (c) NH_3 (d) SO_2

30. Which one of the following has the regular tetrahedral structure ?
(a) BF_4^- (b) SF_4
(c) XeF_4 (d) $[Ni(CN)_4]^{2-}$
(Atomic no. : B = 5, S = 16, Ni = 28, Xe = 54)

31. Among the following, the molecule/ion having linear shape is :
(a) SO_2 (b) CO_2 (c) ClO_2^- (d) NO_2^-

32. The bond angle between two hybrid orbitals is 105°. The percentage of *s*-character of hybrid orbital is between
(a) 50 - 55% (b) 9 - 12%
(c) 21 - 23% (d) 11 - 12%

33. Arrange the following ions in the order of decreasing X – O bond length, where X is the central atom in
(a) $ClO_4^-, SO_4^{2-}, PO_4^{3-}, SiO_4^{4-}$
(b) $SiO_4^{4-}, PO_4^{3-}, SO_4^{2-}, ClO_4^-$
(c) $SiO_4^{4-}, PO_4^{3-}, ClO_4^-, SO_4^{2-}$
(d) $SiO_4^{4-}, SO_4^{2-}, PO_4^{3-}, ClO_4^-$

34. 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
(a) stronger σ bond between B and F in BF_3 as compared 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 between C and F in CF_4.
(d) smaller size of B– atom as compared to C– atom.

35. The number of anti-bonding electron pairs in O_2^{2-} molecular ion on the basis of molecular orbital theory is, (Atomic number of O is 8)
(a) 5 (b) 2 (c) 3 (d) 4

36. In which of the following pairs of molecules/ions, both the species are not likely to exist ?
(a) H_2^+, He_2^{2-} (b) H_2^-, He_2^{2-}
(c) H_2^{2+}, He_2 (d) H_2^-, He_2^{2+}

37. Which one of the following properties is **not** shown by NO?
(a) It is diamagnetic in gaseous state
(b) It is neutral oxide
(c) It combines with oxygen to form nitrogen dioxide
(d) It is bond order is 2.5

38. Which of the following compounds contain(s) no covalent bond(s)?
KCl, PH_3, O_2, B_2H_6, H_2SO_4
(a) KCl, B_2H_6, PH_3 (b) KCl, H_2SO_4
(c) KCl (d) KCl, B_2H_6

39. According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^- ?
(a) Li_2^+ is unstable and Li_2^- is stable
(b) Li_2^+ is stable and Li_2^- is unstable
(c) Both are stable
(d) Both are unstable

40. Molecular shapes of SF_4, CF_4 and XeF_4 are
(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 enolic form of acetone contains
(a) 9 sigma bonds, 1 pi bond and 2 lone pairs
(b) 8 sigma bonds, 2 pi bonds and 2 lone pairs
(c) 10 sigma bonds, 1 pi bond and 1 lone pair
(d) 9 sigma bonds, 2 pi bonds and 1 lone pair

42. Among the following ions the *pπ–dπ* overlap could be present in
(a) NO_2^- (b) NO_3^- (c) PO_4^{3-} (d) CO_3^{2-}

43. Chemical formula for calcium pyrophosphate is $Ca_2P_2O_7$. The formula for ferric pyrophosphate will be
(a) $Fe_3(P_2O_7)_3$ (b) $Fe_4P_4O_{14}$
(c) $Fe_4(P_2O_7)_3$ (d) Fe_3PO_4

44. Among the following molecules : SO_2, SF_4, ClF_3, BrF_5 and XeF_4 which of the following shapes does not describe any of the molecules mentioned?
(a) Bent (b) Trigonal bipyramidal
(c) See-saw (d) T-shape

45. Cl – O bond order in perchlorate ion is
(a) 1.33 (b) 1.50 (c) 1.75 (d) 1.90

Skill Based MCQs

46. Dipole moment is shown by :
(a) *cis*-1, 2-dichloroethene
(b) *trans*-1, 2-dichloroethene
(c) *trans*-2, 3-dichloro-2 pentene
(d) Both (a) and (c)

47. Which bond angle θ would result in the maximum dipole moment for the triatomic molecule YXY
(a) θ = 90° (b) θ = 120° (c) θ = 150° (d) θ = 180°

48. Among the following the pair in which the two species are **not** isostructural is
(a) SiF_4 and SF_4 (b) IO_3^- and XeO_3
(c) BH_4^- and NH_4^+ (d) PF_6^- and SF_6

49. Match List I with List II and select the correct answer :

List I (ion)	List II (Shapes)
(A) ICl_2^-	(p) Linear
(B) BrF_2^+	(q) Pyramidal
(C) ClF_4^-	(r) Tetrahedral
(D) $AlCl_4^-$	(s) Square planar
	(t) Angular

	A	B	C	D
(a)	(p)	(q)	(s)	(t)
(b)	(s)	(t)	(q)	(r)
(c)	(p)	(t)	(s)	(r)
(d)	(t)	(p)	(r)	(s)

50. In pyrophosphoric acid, $H_4P_2O_7$, number of σ and $d\pi - p\pi$ bonds are respectively
(a) 8 and 2 (b) 6 and 2
(c) 12 and zero (d) 12 and 2

51. In the change of NO^+ to NO, the electron is added to
(a) σ - orbital (b) π - orbital
(c) σ* - orbital (d) π* - orbital

52. Four diatomic species are listed below in different sequences. Which of these presents the *correct* order of their increasing bond order ?
(a) $O_2^- < NO < C_2^{2-} < He_2^+$
(b) $NO < C_2^{2-} < O_2^- < He_2^+$
(c) $C_2^{2-} < He_2^+ < NO < O_2^-$
(d) $He_2^+ < O_2^- < NO < C_2^{2-}$

53. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic?
(a) $NO \rightarrow NO^+$ (b) $N_2 \rightarrow N_2^+$
(c) $O_2 \rightarrow O_2^+$ (d) $O_2 \rightarrow O_2^{2-}$

54. The dipole moments of diatomic molecules AB and CD are 10.41D and 10.27 D, respectively while their bond distances are 2.82 and 2.67 Å, respectively. This indicates that
(a) bonding is 100% ionic in both the molecules
(b) AB has more ionic bond character than CD
(c) AB has lesser ionic bond character than CD
(d) bonding is nearly covalent in both the molecules

55. The electronic configuration of four elements L, P, Q and R are given in brackets
L ($1s^2\ 2s^2\ 2p^4$); Q ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$)
P ($1s^2\ 2s^2\ 2p^6\ 3s^1$); R ($1s^2\ 2s^2\ 2p^6\ 3s^2$)
The formulae of ionic compounds that can be formed between these elements are
(a) L_2P, RL, PQ and R_2Q (b) LP, RL, PQ and RQ
(c) P_2L, RL, PQ and RQ_2 (d) LP, R_2L, P_2Q and RQ

ANSWER KEY

Conceptual MCQs																		
1	(b)	**3**	(c)	**5**	(d)	**7**	(a)	**9**	(a)	**11**	(d)	**13**	(d)	**15**	(a)	**17**	(d)	**19**	(c)
2	(b)	**4**	(c)	**6**	(b)	**8**	(b)	**10**	(b)	**12**	(a)	**14**	(a)	**16**	(c)	**18**	(c)	**20**	(d)
Application Based MCQs																			
21	(b)	**24**	(d)	**27**	(c)	**30**	(a)	**33**	(b)	**36**	(c)	**39**	(c)	**42**	(c)	**45**	(c)		
22	(a)	**25**	(b)	**28**	(b)	**31**	(b)	**34**	(b)	**37**	(a)	**40**	(d)	**43**	(c)				
23	(c)	**26**	(d)	**29**	(b)	**32**	(c)	**35**	(d)	**38**	(c)	**41**	(a)	**44**	(b)				
Skill Based MCQs																			
46	(d)	**47**	(a)	**48**	(a)	**49**	(c)	**50**	(d)	**51**	(d)	**52**	(d)	**53**	(a)	**54**	(c)	**55**	(c)