Engineering Daily 17 [Set 03] EV

Periodic Properties of Elements and Chemical Bonding

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. What is the ratio of the total number of σ to π bonds present in a single structure of the tetracyanoethylene molecule?

(A) 8 : 9 (B) 9 : 8 (C) 5 : 9 (D) 9 : 9

2. In propyne ($CH_3 - C \equiv CH$), the σ bond between the triply bonded carbon and the adjacent other carbon is formed by head-on overlap of which two hybrid orbitals?

(A) sp − sp (B) sp^3 − sp
(C) sp − p (D) sp^2 − sp

3. What is the total number of delocalized π-electrons in the planar ring of the borazine molecule?

(A) 3 (B) 12 (C) 6 (D) 18

4. Taking the x-axis as the internuclear axis, which pair of orbitals will form no effective bond (zero overlap)?

(A) s and p_y (B) p_x and p_x
(C) p_y and p_y (D) s and p_x

5. In the complete Lewis structure of pyrophosphoric acid, what are the numbers of bridging bonds (P − O − P) and phosphorus–oxygen double bonds (P = O), respectively?

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

6. What are the hybridization state of the central atom of $XeOF_4$ and its actual effective geometry?

(A) sp^3d^2, square planar
(B) sp^3d^2, square pyramidal
(C) sp^3d, trigonal bipyramidal
(D) sp^3d^3, pentagonal pyramidal

7. To minimise repulsion, in which position do the lone pairs of the central iodine atom in the I_3^- ion lie?

(A) No lone pair is present on the central atom
(B) At either terminal atom
(C) In axial positions
(D) In equatorial positions

8. Which specific d-orbital takes part in the hybridization of the central atom of the PCl_5 molecule?

(A) d_{z^2} (B) d_{xz} (C) $d_{x^2-y^2}$ (D) d_{xy}

9. Which of the following molecules has a bent or 'V' shape in its effective molecular geometry even though the central atom is sp^3 hybridized?

(A) $BeCl_2$ (B) OF_2 (C) SO_2 (D) CO_2

10. In the solid state, what are the hybridizations of the central atoms of the cationic and anionic parts of the PCl_5 crystal, respectively?

(A) sp^3d and sp^3d^2 (B) sp^3d in both
(C) sp^3 and sp^3d^2 (D) sp^3 and sp^3d

11. What is the main reason ClF_3 has a T-shape rather than an ideal trigonal planar shape?

(A) Equal repulsion among the three bond pairs
(B) Presence of two lone pairs in equatorial positions
(C) Contraction of the d-orbitals of chlorine
(D) Two lone pairs in axial positions

12. Which of the following anions has a completely linear geometry?

(A) SO_3^{2-} (B) N_3^- (C) NO_2^- (D) ClO_2^-

13. According to VSEPR theory, what is the correct geometry of the XeF_6 molecule?

(A) Regular octahedral (B) Distorted octahedral
(C) Tetrahedral (D) Pentagonal bipyramidal

14. In which of the following molecules is the ratio of bond pairs to lone pairs in the valence shell of the central atom 4 : 1?

(A) NH_3 (B) CH_4 (C) SF_4 (D) XeF_4

15. Which statement is absolutely true for the three species NH_4^+, CH_4 and SO_4^{2-}?

(A) Same hybridization but different shapes
(B) Each has one lone pair on the central atom
(C) All are sp^3 hybridized and tetrahedral
(D) Central atoms have the same number of valence electrons

16. According to Drago's rule, in which of the following hydrides does the central atom undergo almost no hybridization, with the bonds formed by pure p-orbitals?

(A) CH_4 (B) PH_3 (C) H_2O (D) NH_3

17. What is the correct order of bond angles of the hydrides of group-16 elements?

(A) $H_2O < H_2S < H_2Se < H_2Te$
(B) $H_2O = H_2S = H_2Se = H_2Te$
(C) $H_2O > H_2S > H_2Se > H_2Te$
(D) $H_2Te > H_2Se > H_2S > H_2O$

18. In which of the following compounds does the central atom hold 12 electrons in its valence shell through octet expansion?

(A) $BeCl_2$ (B) BF_3 (C) SF_6 (D) CCl_4

19. What is the main reason for the significant decrease in the bond angle of NF_3 compared with NH_3?

(A) Reduced bond-pair repulsion

(B) High electronegativity of nitrogen

(C) Absence of lone pairs on fluorine

(D) Smaller size of fluorine than hydrogen

20. Among the oxides of nitrogen and related ions, which has the largest bond angle?

(A) NO_3^- (B) NO_2 (C) NO_2^- (D) NO_2^+

21. What is the correct relationship between the axial and equatorial bond lengths in the PCl_5 molecule?

(A) The compound has no distinct axial bonds

(B) $P-Cl_{axial} = P-Cl_{equatorial}$

(C) $P-Cl_{axial} < P-Cl_{equatorial}$

(D) $P-Cl_{axial} > P-Cl_{equatorial}$

22. Which of the following gaseous molecules shows paramagnetism because it contains an unpaired electron?

(A) CO_2 (B) N_2O_4 (C) N_2O (D) NO_2

23. What is the hybridization state of the two aluminium atoms in the structure of dimeric aluminium chloride (Al_2Cl_6)?

(A) dsp^2 (B) sp^2 (C) sp^3d (D) sp^3

24. In which of the following molecules does the central atom have an incomplete octet?

(A) $SiCl_4$ (B) CCl_4 (C) BCl_3 (D) PCl_3

25. How many types of chemical bonds in total, including water of crystallisation, are present in a crystal of blue vitriol ($CuSO_4 \cdot 5H_2O$)?

(A) Only ionic and covalent (B) 4 types

(C) 2 types (D) 3 types

26. What is the ratio of the number of covalent bonds to coordinate covalent bonds in the H_3O^+ ion?

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

27. What is the nature of distribution of electrons and centres in the bridge bond of Al_2Cl_6?

(A) 3-centre 2-electron (B) 2-centre 4-electron

(C) 3-centre 4-electron (D) 2-centre 2-electron

28. Which classes of bonds in total are present in an NH_4Cl crystal?

(A) Ionic, covalent and hydrogen bonds

(B) Only ionic and covalent

(C) Only covalent and coordinate

(D) Ionic, covalent and coordinate covalent

29. Among the chlorides of the third-period elements, which has the lowest melting point?

(A) NaCl (B) $AlCl_3$ (C) $MgCl_2$ (D) $SiCl_4$

30. Which of the group-2 carbonate salts has the lowest thermal decomposition temperature?

(A) $BeCO_3$ (B) $MgCO_3$ (C) $BaCO_3$ (D) $CaCO_3$

31. According to Fajans' rule, which of the following cations has the highest polarising power or ionic potential (ϕ)?

(A) Na^+ (B) Al^{3+} (C) Mg^{2+} (D) K^+

32. What is the correct order of solubility of group-2 sulfate salts in water?

(A) $MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

(B) $CaSO_4 > MgSO_4 > BaSO_4 > SrSO_4$

(C) All have equal solubility

(D) $BaSO_4 > SrSO_4 > CaSO_4 > MgSO_4$

33. Among the halide anions below, which has the highest tendency to be polarised (polarisability)?

(A) F^- (B) I^- (C) Cl^- (D) Br^-

34. Which molecule has a net dipole moment of zero even though every individual bond is polar?

(A) BF_3 (B) NF_3 (C) H_2O (D) NH_3

35. What is the experimentally correct order of the dipole moments of the chlorine-substituted derivatives of methane?

(A) $CHCl_3 > CH_2Cl_2 > CH_3Cl > CCl_4$

(B) $CH_2Cl_2 > CH_3Cl > CHCl_3 > CCl_4$

(C) $CH_3Cl > CH_2Cl_2 > CHCl_3 > CCl_4$

(D) $CCl_4 > CHCl_3 > CH_2Cl_2 > CH_3Cl$

36. Which of the positional isomers of dichlorobenzene has zero net dipole moment ($\mu = 0$)?

(A) None has a zero dipole moment

(B) 1,3-dichlorobenzene

(C) 1,2-dichlorobenzene

(D) 1,4-dichlorobenzene

37. Which comparison of the experimental dipole moments of NH_3 and NF_3 is correct?

(A) $\mu(NH_3) < \mu(NF_3)$

(B) Both molecules have zero dipole moment

(C) $\mu(NH_3) = \mu(NF_3)$

(D) $\mu(NH_3) > \mu(NF_3)$

38. Which isomer of nitrophenol is easily vaporised because of intramolecular hydrogen bonding?

(A) meta-nitrophenol (B) para-nitrophenol

(C) ortho-nitrophenol (D) 2,4-dinitrophenol

39. According to molecular orbital theory, what is the correct decreasing order of bond order of the O_2 molecule and its ions?

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

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

40. What is the underlying chemical reason for the density of H_2O being maximum at 4°C?

(A) Spontaneous breaking of covalent bonds

(B) Sudden drop in viscosity

(C) Breakdown of the ice-like open cage structure

(D) Complete loss of hydrogen bonds

41. What is the reason for ethanoic acid (CH_3COOH) showing an apparent molecular mass double the normal value in a non-polar solvent?

(A) Coordinate covalent bonding

(B) Dimerisation through hydrogen bonding

(C) Ion–dipole interaction

(D) Weak van der Waals attraction

42. Which of the following diatomic molecules is diamagnetic and has bond order 3?

(A) O_2 (B) B_2 (C) N_2 (D) NO

43. According to the molecular orbital configuration of the CO molecule, what is the value of its effective bond order?

(A) 2.5 (B) 1.5 (C) 2.0 (D) 3.0

44. What is the bond order of each carbon–oxygen bond in the CO_3^{2-} ion because of the resonance hybrid?

(A) 1.50 (B) 1.00 (C) 2.00 (D) 1.33

45. What is the main reason for the steady decrease in melting point of the group-1 alkali metals from top to bottom?

(A) Fewer valence electrons

(B) Closer packing of the crystal

(C) Higher cationic charge

(D) Weaker metallic bonding in larger atoms

46. Which theory most logically explains the lustre and high thermal and electrical conductivity of metals?

(A) Hybridization model

(B) Free electron sea model

(C) VSEPR theory

(D) Bohr–Sommerfeld model

47. Which of KCN and NH_4Cl has the coexistence of all three — ionic, covalent and coordinate bonds?

(A) Only NH_4Cl (B) Both

(C) Neither (D) Only KCN

48. What is the main reason CuCl has much greater covalent character than KCl?

(A) Change in the shape of Cl^-

(B) High melting point of Cu

(C) $18e^-$ configuration of Cu^+

(D) Greater reactivity of K

49. What is the fundamental reason the intensity of colour increases progressively from AgF to AgI among silver halides?

(A) Increase in lattice energy

(B) Increase in anion polarizability

(C) Change in oxidation number of Ag

(D) Decrease in cation size

50. Dissolving KF in liquid HF gives a stable salt. What is the formula of the anion present in it?

(A) H_2F^+ (B) F_2^{2-} (C) HF_3^{2-} (D) HF_2^-