Engineering Daily 17 [Home Practice] EV

Periodic Properties of Elements and Chemical Bonding

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

MCQ 50 marks

1. What are the total numbers of σ bonds, π bonds and lone pairs of electrons in the complete Lewis structure of a single aspirin molecule?

(A) 20σ, 4π, 6 pairs (B) 21σ, 5π, 8 pairs

(C) 21σ, 5π, 4 pairs (D) 19σ, 5π, 8 pairs

2. In which pair do both central atoms have sp^3d^2 hybridization, yet their effective geometries are square pyramidal and square planar, respectively?

(A) XeO_3 and XeF_2 (B) BrF_5 and XeF_4

(C) SF_6 and XeF_4 (D) PCl_5 and IF_5

3. How many bridging bonds (S − O − S) and how many terminal double bonds (S = O) are present in the ring of the cyclic $(SO_3)_3$ trimer?

(A) 3 bridging bonds and 6 double bonds

(B) 2 bridging bonds and 4 double bonds

(C) No bridging bond

(D) 3 bridging bonds and 3 double bonds

4. What are the hybridization and number of lone pairs of the central atoms of the anions $[ICl_4]^-$ and $[ICl_2]^-$, respectively?

(A) sp^3d (1 lone pair) and sp^3 (2 lone pairs)

(B) sp^3d^2 (2 lone pairs) and sp^3d (3 lone pairs)

(C) sp^3d^2 (1 lone pair) and sp^3d (2 lone pairs)

(D) sp^3d in both, with 2 and 3 lone pairs respectively

5. In the see-saw structure of the SF_4 molecule, the axial bond angle contracts from the ideal 180° to approximately how many degrees?

(A) 90° (B) 109.5° (C) 173° (D) 120°

6. In Berry pseudorotation of a trigonal bipyramidal molecule, what mainly happens?

(A) Breakdown into four ligands

(B) Rapid axial–equatorial ligand exchange

(C) Change to tetrahedral hybridization

(D) Change in oxidation number of the central atom

7. Which hypervalent model applies in explaining the linear bonding in XeF_2 without direct help from vacant d-orbitals?

(A) 3c − 2e bonding model (B) 2c − 2e π-bond model

(C) Purely ionic model (D) 3c − 4e bonding model

8. What is the formal charge of the central nitrogen atom in the most stable Lewis resonance structure of HNO_3?

(A) +2 (B) 0 (C) +1 (D) −1

9. What is the experimentally correct order of Lewis acid strength of the boron trihalides?

(A) $BF_3 > BCl_3 > BBr_3 > BI_3$

(B) All have equal Lewis acid strength

(C) $BF_3 < BCl_3 < BBr_3 < BI_3$

(D) $BCl_3 > BF_3 > BBr_3 > BI_3$

10. In line with the sizes of the halogens, which condition of back-bonding is responsible for BF_3 having the lowest Lewis acidity?

(A) Vacant d-orbitals on boron

(B) No lone pair on fluorine

(C) Effective 2pπ − 2pπ back-bonding

(D) Large orbital size mismatch

11. Besides the ionic bond between the cation and anion in CaC_2, what bonds are present in the structure of the carbide anion (C_2^{2-}) itself?

(A) Three σ bonds

(B) Only an ionic bond

(C) Two σ and one π bond

(D) One σ and two π bonds

12. Considering the Born–Haber cycle and the dominance of lattice energy, which of the following ionic compounds has the highest melting point (2852°C)?

(A) $CaCl_2$ (B) Na_2O (C) MgF_2 (D) MgO

13. According to the Born–Landé equation ($U \propto \frac{|z_+ z_-|}{r_0}$), which of the following ionic crystals has the most negative lattice enthalpy?

(A) $AlCl_3$ (B) LiF (C) MgO (D) Al_2O_3

14. Which of the following metal carbonates decomposes spontaneously on slight heating to give the corresponding metal oxide and CO_2 gas?

(A) K_2CO_3 (B) Ag_2CO_3

(C) Rb_2CO_3 (D) Na_2CO_3

15. What are the hybridization state of the central oxygen atom of the ozone (O_3) molecule and the actual bond angle with the terminal oxygens, respectively?

(A) sp^3d and 120° (B) sp and 180°

(C) sp^3 and 104.5° (D) sp^2 and about 116.8°

16. Which of the following ions has a symmetric hydrogen bond, where the proton lies exactly midway between the two terminal atoms?

(A) $[F - H - F]^-$ (B) $[Cl - H - Cl]^-$

(C) liquid NH_3 (D) $[H_3O]^+$

17. According to molecular orbital theory, what are the bond order and magnetic property of the peroxide anion (O_2^{2-}), respectively?

(A) Bond order = 1.5, paramagnetic

(B) Bond order = 1, diamagnetic

(C) Bond order = 0, unstable

(D) Bond order = 2, paramagnetic

18. Which species among the following nitrogen monoxide derivatives has the shortest bond length?

(A) NO (B) NO^{2-} (C) NO^{-} (D) NO^{+}

19. According to molecular orbital theory, in which type of orbitals do the two unpaired electrons of the diatomic B_2 molecule mainly reside?

(A) Bonding σ_{2p_z} (B) Antibonding σ^*_{2s}

(C) Bonding π_{2p_x} and π_{2p_y} (D) Antibonding π^*_{2p}

20. What is the correct decreasing order of carbon–carbon covalent bond distances?

(A) C − C > C = C > C ≡ C

(B) C = C > C ≡ C > C − C

(C) All have equal length

(D) C ≡ C > C = C > C − C

21. What is the correct decreasing order of bond dissociation enthalpy of carbon–halogen bonds?

(A) C − F < C − Cl < C − Br < C − I

(B) C − I > C − Br > C − Cl > C − F

(C) C − F > C − Cl > C − Br > C − I

(D) C − Cl > C − F > C − Br > C − I

22. What is the main reason for the bond dissociation enthalpy of the F_2 molecule being unexpectedly lower than that of the Cl_2 molecule?

(A) d-orbitals in fluorine

(B) Higher electronegativity of chlorine

(C) Lower atomic mass of fluorine

(D) Lone pair repulsion due to the small size of fluorine

23. What is the special bond formed by incomplete head-on overlap of orbitals in the cyclopropane ring, where the C − C − C bond angle is about 60°?

(A) Axial pi bond

(B) Hydrogen bridge bond

(C) Pure sp^2 covalent bond

(D) Banana bond or bent bond

24. What are the hybridization and geometric shape of the central sulfur atom of the dimethyl sulfoxide ($(CH_3)_2SO$) molecule?

(A) dsp^2, square planar (B) sp^2, trigonal planar

(C) sp^3, trigonal pyramidal (D) sp^3, tetrahedral

25. Which pair of ions is isoelectronic and also isostructural with each other?

(A) SO_3^{2-} and NO_3^{-} (B) BF_3 and SO_3^{2-}

(C) ClO_3^{-} and CO_3^{2-} (D) CO_3^{2-} and NO_3^{-}

26. What is the reason CO_2 is gaseous at room temperature while SiO_2 is a high-melting, non-volatile solid?

(A) Network structure of SiO_2

(B) Ionic bonding in SiO_2

(C) Higher atomic mass of silicon

(D) Higher electronegativity of silicon

27. Why does $K_2Cr_2O_7$ show an intense orange colour even though chromium has no unpaired d-electrons?

(A) d − d electron transitions

(B) Magnetic property of chromium

(C) Ligand-to-metal charge transfer

(D) Presence of potassium ions

28. In which crystal does the carbon–carbon bond length remain fixed as a pure single-bond length, rather than intermediate between single and double bonds, due to the absence of resonance?

(A) CO_3^{2-} (B) Benzene

(C) Diamond (D) Ozone

29. What is the correct decreasing order of the percentage covalent character of NaCl, $MgCl_2$ and $AlCl_3$?

(A) $AlCl_3 > MgCl_2 > NaCl$

(B) $NaCl > MgCl_2 > AlCl_3$

(C) All have equal covalent character

(D) $MgCl_2 > NaCl > AlCl_3$

30. Comparing the nature and length of the carbon–carbon bonds in diamond and graphite, which statement is correct?

(A) The C–C bond in diamond is shorter than the in-layer C–C bond in graphite

(B) The in-layer C–C bond in graphite is shorter and stronger than the C–C bond in diamond

(C) The C–C bond lengths in diamond and graphite are equal

(D) The C–C bonds in graphite are purely single bonds

31. According to the conventional textbook bonding model, what is the reason for the nearly planar geometry and comparatively low basicity of the N atom in $(SiH_3)_3N$?

(A) Orbital interaction between the lone pair on N and the Si centres

(B) Completely ionic nature of the Si–H bonds

(C) sp^3d hybridization of the N atom

(D) Absence of a lone pair on the N atom

32. According to Bent's rule, which statement about the distribution of s and p character in the hybrid orbitals of a central atom is correct?

(A) More p-character is directed towards the more electronegative substituent

(B) Electronegativity does not affect the character of hybrid orbitals

(C) More s-character is directed towards the more electronegative substituent

(D) s- and p-character are equal towards all substituents

33. In which of the following species does the central atom's lone pair behave as stereochemically inactive, so that an almost regular octahedral geometry is retained without significant distortion?

(A) XeF_6 (B) SF_4

(C) IF_5 (D) $[SeCl_6]^{2-}$

34. What is the geometrical shape of the IF_7 molecule?

(A) Octahedral (B) Trigonal bipyramidal

(C) Square pyramidal (D) Pentagonal bipyramidal

35. According to the conventional $p\pi - p\pi/p\pi - d\pi$ back-bonding concept, in which of the following species is back-bonding not expected?

(A) $:CCl_2$ (B) BF_3 (C) NF_3 (D) H_3BO_3

36. In which of the following species is the number of bond pairs and lone pairs around the central atom 2 and 3, respectively?

(A) ClF_3 (B) XeF_2 (C) XeF_4 (D) SF_4

37. Which statement is correct about the hybridization of the central atom of the OCS molecule and its net dipole moment?

(A) sp^2, $\mu = 0$ (B) sp, $\mu \neq 0$

(C) sp, $\mu = 0$ (D) sp^3, $\mu \neq 0$

38. Which alkali metal chloride readily forms hydrated crystals because of its high hydration tendency?

(A) NaCl (B) CsCl (C) LiCl (D) KCl

39. What is the main reason for the intense purple colour of the permanganate ion (MnO_4^-)?

(A) Ligand-to-metal charge transfer (LMCT)

(B) d − d transition

(C) f − f transition

(D) Metal-to-ligand charge transfer (MLCT)

40. What is an important reason why salicylic acid is more acidic than p-hydroxybenzoic acid?

(A) Strong +I effect of the $-OH$ group

(B) Stabilization of the conjugate base by intramolecular hydrogen bonding

(C) Increase in basicity of the $-COOH$ group

(D) Loss of aromaticity of the benzene ring

41. In the conventional Lewis structure of the I_3^- ion, what is the formal charge on each terminal iodine atom?

(A) −1.00 (B) −0.50 (C) 0.00 (D) −0.33

42. Although the individual hydrogen bond in HF is stronger, what is the main reason the boiling point of H_2O is much higher than that of HF?

(A) H_2O forms a more extensive three-dimensional hydrogen-bond network

(B) HF cannot form any hydrogen bond

(C) Oxygen in H_2O has no lone pair

(D) The molecular mass of H_2O is much greater than that of HF

43. What is the main reason chloral (CCl_3CHO) readily forms the stable chloral hydrate [$CCl_3CH(OH)_2$]?

(A) High atomic mass of the Cl atoms

(B) sp hybridization of the carbonyl carbon

(C) Cl atoms acting as hydrogen-bond donors

(D) Strong −I effect of the CCl_3- group

44. According to simple molecular orbital theory (MOT), which orbitals provide the main bonding contribution to the bond order of 2 in the C_2 molecule?

(A) Two antibonding orbitals

(B) One σ and one π bonding orbital

(C) Two degenerate π bonding orbitals

(D) Two σ bonding orbitals

45. Why does boric acid (H_3BO_3) behave as an acid in aqueous solution without directly donating a proton itself?

(A) It accepts H^+ from water

(B) It donates three protons as a strong Brønsted acid

(C) It acts as a Lewis acid by accepting OH^- from water

(D) It acts as an amphoteric oxide

46. Which metal has a melting point of about 3422°C because of its extremely strong metallic/cohesive bonding?

(A) Tungsten (W) (B) Copper (Cu)

(C) Zinc (Zn) (D) Rubidium (Rb)

47. Why does a dilute solution of an alkali metal in liquid NH_3 turn intense blue and become paramagnetic?

(A) Formation of solvated electrons

(B) Polymerization of amide ions

(C) Evolution of H_2 gas

(D) Formation of metal hydride

48. What are the conventional hybridization and molecular geometry of the central phosphorus atom in the $POCl_3$ molecule?

Ⓐ **dsp^2, square planar**

Ⓑ **sp^2, trigonal planar**

Ⓒ **sp^3d, trigonal bipyramidal**

Ⓓ **sp^3, tetrahedral**

49. What is the main reason the axial P–Cl bonds in PCl_5 are longer and weaker than the equatorial P–Cl bonds?

Ⓐ **The equatorial P–Cl bonds have π-character**

Ⓑ **The axial P–Cl bonds are ionic in nature**

Ⓒ **The axial Cl atoms have lower electronegativity**

Ⓓ **Each axial bond experiences 90° repulsion from three equatorial bond pairs**

50. Considering Fajans' rule and solubility trends, which silver halide is the least soluble in water?

Ⓐ **AgF** Ⓑ **AgI** Ⓒ **AgBr** Ⓓ **AgCl**