# Engineering Daily 17 [Set 04] 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 the dicyanoacetylene molecule?

(A) 5 : 6 (B) 4 : 5 (C) 5 : 5 (D) 3 : 6

2. In but-1-en-3-yne ($CH_2 = CH - C \equiv CH$), what are the hybridization states of the two carbon atoms joined by the single bond, respectively?

(A) $sp^2 - sp^2$ (B) $sp - sp$

(C) $sp^2 - sp$ (D) $sp^3 - sp$

3. What is the ratio of the number of delocalized π-electrons in the benzene ($C_6H_6$) ring to the total number of σ bonds present?

(A) 1 : 4 (B) 1 : 1 (C) 1 : 2 (D) 2 : 3

4. Taking the z-axis as the internuclear axis, lateral overlap of which pair of orbitals will form a pure π bond?

(A) s and s (B) $p_z$ and $p_z$ (C) s and $p_z$ (D) $p_x$ and $p_x$

5. In the structural drawing of oleum, what are the numbers of bridging bonds (S − O − S) and sulfur–oxygen double bonds (S = O), respectively?

(A) 1 and 4 (B) 2 and 4

(C) 1 and 2 (D) 2 and 2

6. What is the hybridisation of the central atom in the $XeO_2F_2$ molecule, and what is its effective spatial geometry?

(A) $sp^3$, tetrahedral (B) $sp^3d^2$, square planar

(C) $sp^3d$, see-saw (D) $sp^3d$, T-shaped

7. What are the correct molecular geometry of the $Br_3^-$ anion and the number of lone pairs on the central bromine, respectively?

(A) T-shaped, 2 (B) Linear, 3

(C) Bent, 2 (D) Trigonal planar, 0

8. Which two d-orbitals take part in the octahedral hybridization of the central atom of the $SF_6$ molecule?

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

(C) $d_{xy}$ and $d_{yz}$ (D) $d_{x^2-y^2}$ and $d_{z^2}$

9. In the solid state, $N_2O_5$ exists as an ionic pair ( $[NO_2^+][NO_3^-]$). What are the hybridizations of nitrogen in the cationic and anionic parts, respectively?

(A) sp and $sp^2$ (B) sp and $sp^3$

(C) $sp^2$ in both (D) $sp^2$ and $sp^3$

10. Which of the following anions is bent rather than linear?

(A) $NO_2^-$ (B) $I_3^-$ (C) $N_3^-$ (D) $SCN^-$

11. What are the hybridization of the central oxygen of the $Cl_2O$ molecule and its effective geometry?

(A) $sp^3d$, linear (B) $sp^2$, trigonal planar

(C) $sp^3$, bent (D) sp, linear

12. How many lone pairs of electrons in total (including central and terminal atoms) are present in a single structure of the $XeF_4$ molecule?

(A) 16 (B) 2 (C) 14 (D) 12

13. What are the numbers of bond pairs and lone pairs, respectively, in the valence shell of the central atom of the $TeCl_4$ molecule?

(A) 4 and 1 (B) 3 and 2

(C) 5 and 0 (D) 4 and 2

14. Which statement is 100% accurate for the three species $CO_3^{2-}$, $NO_3^-$ and $BF_3$?

(A) Same bond angle but different hybridization

(B) $CO_3^{2-}$ is pyramidal

(C) Each has a different total number of electrons

(D) All are $sp^2$ hybridized and trigonal planar

15. In which of the hydrides of group-15 elements does the lone pair of the central atom not take part in hybridization and reside in an almost pure s-orbital?

(A) $SiH_4$ (B) $NH_3$ (C) $AsH_3$ (D) $CH_4$

16. What is the correct decreasing order of bond angles of the hydrides of group-15 elements?

(A) All values are nearly equal

(B) $NH_3 < PH_3 < AsH_3 < SbH_3$

(C) $NH_3 > PH_3 > AsH_3 > SbH_3$

(D) $SbH_3 > AsH_3 > PH_3 > NH_3$

17. What is the main reason for the bond angle of $OF_2$ being smaller than that of $H_2O$?

(A) Change in size of oxygen

(B) Reduced bond-pair repulsion

(C) Three lone pairs on fluorine

(D) High dipole moment of the compound

18. In which of the following species is the bond angle at the central atom the smallest?

(A) $NH_2^-$ (B) $NH_3$ (C) $CH_4$ (D) $NH_4^+$

19. What is the bond angle between the axial and equatorial fluorine atoms in the $PF_5$ molecule?

(A) 180° (B) 90° (C) 109.5° (D) 120°

20. Which chlorine oxide shows strong paramagnetism because it contains an unpaired electron?

(A) $Cl_2O_6$ (B) $Cl_2O_7$ (C) $Cl_2O$ (D) $ClO_2$

21. In the stable Lewis structure of $H_2SO_4$, how many electrons in total are present in the outer shell of the central S atom?

Ⓐ 14 Ⓑ 12 Ⓒ 10 Ⓓ 8

22. What is the hybridization state of each boron atom in the diborane ($B_2H_6$) compound?

Ⓐ $sp^3$ Ⓑ sp Ⓒ $sp^2$ Ⓓ $dsp^2$

23. How many electrons are present in the valence shell of beryllium in a single monomer of $BeCl_2$ in the vapour state?

Ⓐ 4 Ⓑ 8 Ⓒ 2 Ⓓ 6

24. Which types of chemical bonds in total are present in a $[Cu(NH_3)_4]SO_4$ crystal?

Ⓐ Only ionic and coordinate

Ⓑ Only coordinate and covalent

Ⓒ Ionic, covalent and coordinate covalent

Ⓓ Only ionic and covalent

25. In the triple bond of the CO molecule, which atoms are the electron donor and acceptor of the coordinate bond, respectively?

Ⓐ Both atoms share equally

Ⓑ Oxygen donor, carbon acceptor

Ⓒ Carbon donor, oxygen acceptor

Ⓓ There is no coordinate bond

26. What is the electron cluster arrangement of the bridge bond (banana bond) of diborane ($B_2H_6$)?

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

Ⓒ 2-centre 2-electron Ⓓ 2-centre 4-electron

27. Which classes of chemical bonds are present in the compound $K_4[Fe(CN)_6]$?

Ⓐ Ionic and hydrogen bonds

Ⓑ Only coordinate covalent

Ⓒ Only ionic and covalent

Ⓓ Ionic, covalent and coordinate covalent

28. Among the singly charged cations of the alkali metals, which has the lowest polarising power?

Ⓐ $Li^+$ Ⓑ $Na^+$ Ⓒ $K^+$ Ⓓ $Cs^+$

29. Among the chlorides of the alkaline earth metals, which has the greatest covalent character and hence the lowest melting point?

Ⓐ $MgCl_2$ Ⓑ $CaCl_2$ Ⓒ $BaCl_2$ Ⓓ $BeCl_2$

30. Which molecule has a non-zero net dipole moment ( $\mu \neq 0$) because of asymmetry in its geometry?

Ⓐ $CO_2$ Ⓑ $SO_2$ Ⓒ $BeF_2$ Ⓓ $CS_2$

31. Among the lithium halides, which has the greatest covalent character and hence dissolves most easily in organic solvents?

Ⓐ LiI Ⓑ LiF Ⓒ LiCl Ⓓ LiBr

32. Despite having nearly equal size and equal charge, what is the reason AgCl has a significantly lower melting point than KCl?

Ⓐ $18e^-$ configuration of $Ag^+$

Ⓑ Smaller size of potassium

Ⓒ Silver being a heavy metal

Ⓓ Greater chloride polarisation in potassium

33. What is the reason for $PbF_2$ being colourless while $PbI_2$ is intensely bright yellow?

Ⓐ Change in oxidation state of lead

Ⓑ Strong polarisation of fluoride

Ⓒ Charge-transfer absorption by $I^-$

Ⓓ Emission of iodine's own colour

34. Why does $BaCO_3$ require a comparatively higher temperature than $CaCO_3$ for thermal decomposition?

Ⓐ Higher atomic mass of barium

Ⓑ $CaCO_3$ being less ionic

Ⓒ Weak polarising power of larger $Ba^{2+}$

Ⓓ Larger size of calcium

35. What is the correct ascending order of solubility of the group-2 alkaline earth metal hydroxides in water?

Ⓐ $Ba(OH)_2 < Ca(OH)_2 < Mg(OH)_2 < Be(OH)_2$

Ⓑ $Mg(OH)_2 < Be(OH)_2 < Ca(OH)_2 < Ba(OH)_2$

Ⓒ All have nearly equal solubility

Ⓓ $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Ba(OH)_2$

36. Which of the geometric isomers of 1,2-dichloroethene (CHCl = CHCl) has zero net dipole moment?

Ⓐ cis isomer Ⓑ trans isomer

Ⓒ Both isomers have zero Ⓓ Neither has zero

37. What is the mathematical basis for the net dipole moment of the planar trigonal $BF_3$ molecule being zero?

Ⓐ Non-polar bonds

Ⓑ Ionic character of the molecule

Ⓒ Zero vector sum of bond moments

Ⓓ Neutral partial charge on fluorine

38. In which pair of molecules do both members have completely zero net dipole moment?

Ⓐ $NH_3$ and $NF_3$ Ⓑ $CO_2$ and $CCl_4$

Ⓒ $H_2O$ and $SO_2$ Ⓓ $CH_3Cl$ and $CH_4$

39. What is the effective geometry of the $BrF_3$ molecule?

Ⓐ Trigonal planar Ⓑ Trigonal pyramidal

Ⓒ Tetrahedral Ⓓ T-shaped

40. Presence of which specific hydrogen bond makes salicylaldehyde steam volatile?

(A) Dipole–ion bond

(B) Intramolecular hydrogen bond

(C) Intermolecular hydrogen bond

(D) Weak dispersion force

41. What is the reason for the boiling point and water solubility of p-nitrophenol being significantly higher than those of o-nitrophenol?

(A) Higher density of the o-isomer

(B) No resonance in the p-isomer

(C) Intermolecular H-bonding in the p-isomer

(D) Intramolecular H-bonding in the p-isomer

42. What is the main driving force behind the formation of the zig-zag chain structure of HF in the liquid state?

(A) Vacant d-orbitals on fluorine

(B) Strong hydrogen bonding

(C) London dispersion force

(D) Coordinate covalent bonding

43. What is the reason for the volume of water contracting as ice melts and is heated from 0°C to 4°C?

(A) Shorter covalent bonds

(B) Loss of hydrogen gas

(C) Higher autoionisation of water

(D) Partial collapse of the open cage structure

44. What are the bond order values of the $N_2$ molecule and its related ions, respectively?

(A) $N_2 = 3.0, N_2^+ = 2.0, N_2^- = 2.5$

(B) $N_2 = 3.0, N_2^+ = 2.5, N_2^- = 2.5$

(C) $N_2 = 3.0, N_2^+ = 3.0, N_2^- = 2.5$

(D) $N_2 = 2.5, N_2^+ = 3.0, N_2^- = 2.0$

45. According to molecular orbital theory, the paramagnetism of the $B_2$ molecule is due to the presence of unpaired electrons in which orbitals?

(A) $\sigma_{2p_z}$ (B) $\pi^*_{2p_x}$

(C) $\sigma^*_{2s}$ (D) Degenerate $\pi_{2p_x}$ and $\pi_{2p_y}$

46. What is the bond order of the $NO^+$ cation based on molecular orbital theory?

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

47. What is the bond order of each phosphorus–oxygen bond in the $PO_4^{3-}$ ion in view of the resonance hybrid?

(A) 1.25 (B) 1.00 (C) 1.33 (D) 1.50

48. What is the reason for the melting point of metallic Al being many times higher than that of Na?

(A) Aluminium being a metalloid

(B) Abnormally low melting point of sodium

(C) Larger atomic radius of aluminium

(D) Higher charge density in aluminium

49. Which model explains the ductility of metallic crystals and their property of becoming thin sheets on hammering instead of breaking?

(A) Hybridization theory

(B) Crystal field theory

(C) Molecular orbital theory

(D) Free electron sea model

50. Which classes of chemical bonds are simultaneously present in a $CH_3COONa$ crystal?

(A) Ionic and covalent bonds

(B) Only ionic bonds

(C) Only covalent bonds

(D) Ionic, covalent and coordinate bonds