MCQ 50 marks

1. **A.** 5 : 6

Explanation: Dicyanoacetylene N ≡ C − C ≡ C − C ≡ N has 3 triple bonds and 2 single bonds.
σ bonds = 3 + 2 = 5
π bonds = 3 × 2 = 6
Therefore, σ : π = 5 : 6

2. **C.** $sp^2 - sp$

Explanation: The carbon of the $CH_2 = CH-$ part is sp^2 and the carbon of the $-C \equiv CH$ part is sp hybridized.
Therefore, the carbons joined by the single bond are $sp^2 - sp$

3. **C.** 1 : 2

Explanation: σ bonds = 6 (C − C) + 6 (C − H) = 12
Delocalized π-electrons = 6
Therefore, the ratio = 6 : 12 = 1 : 2

4. **D.** p_x **and** p_x

Explanation: Head-on overlap along the z-axis forms a σ bond.
The p_x and p_x orbitals overlap sideways, perpendicular to the z-axis, forming a pure π bond.

5. **A.** 1 **and** 4

Explanation: In oleum $H_2S_2O_7$, the two S atoms are joined through one O, so bridging bonds = 1
Each S carries 2 S = O, so double bonds = 2 × 2 = 4

6. **C.** sp^3d**, see-saw**

Explanation: Steric number = $\frac{1}{2}(V + M)$
Here, V = 8, M = 2
So, steric number = $\frac{1}{2}(8 + 2) = 5$
Therefore, the hybridisation is sp^3d and lone pairs = 5 − 4 = 1, so the shape is see-saw

7. **B. Linear, 3**

Explanation: In Br_3^-, the steric number of the central Br is 2 + 3 = 5 (sp^3d).
The 3 lone pairs occupy equatorial positions, so the shape is linear.

8. **D.** $d_{x^2-y^2}$ **and** d_{z^2}

Explanation: SF_6 undergoes sp^3d^2 hybridization; the axially directed $d_{x^2-y^2}$ and d_{z^2} orbitals take part.

9. **A.** sp **and** sp^2

Explanation: NO_2^+: steric number = 2, hybridization sp
NO_3^-: steric number = 3, hybridization sp^2

10. **A.** NO_2^-

Explanation: In NO_2^-, the steric number of N is 2 + 1 = 3 (sp^2).
Because of the one lone pair, the shape is bent.

11. **C.** sp^3**, bent**

Explanation: In Cl_2O, the steric number of O is 2 + 2 = 4 (2 bond pairs and 2 lone pairs).
Therefore, hybridization is sp^3 and the shape is bent

12. **C. 14**

Explanation: Lone pairs on Xe = 2
Each of the 4 F atoms has 3 lone pairs, total = 4 × 3 = 12
Therefore, total lone pairs = 2 + 12 = 14

13. **A.** 4 **and** 1

Explanation: Valence electrons of Te = 6
Used in 4 Te − Cl bonds = 4
Remaining = 6 − 4 = 2 electrons = 1 lone pair
Therefore, bond pairs = 4, lone pairs = 1

14. **D. All are** sp^2 **hybridized and trigonal planar**

Explanation: In all three species, the steric number of the central atom is 3 with no lone pair.
Therefore, each is sp^2 hybridized with a trigonal planar shape.

15. **C.** AsH_3

Explanation: Because the energy gap between the s and p orbitals of As is large, hybridization hardly occurs in AsH_3.
The bond angle is nearly 90° (≈ 92°), so the

bonds use almost pure p-orbitals and the lone pair resides in an almost pure s-orbital.

16. **C.** $NH_3 > PH_3 > AsH_3 > SbH_3$
Explanation: As the size of the central atom increases and its electronegativity decreases, the bond pairs move away from the centre and repulsion decreases.
Therefore, NH_3 (107°) > PH_3 (93.5°) > AsH_3 (92°) > SbH_3 (91°)

17. **B. Reduced bond-pair repulsion**
Explanation: F is highly electronegative, so the O − F bond pairs shift towards F.
This reduces bond pair–bond pair repulsion near O, so the bond angle falls from H_2O (104.5°) to OF_2 (103°).

18. **A.** NH_2^-
Explanation: NH_4^+ and CH_4 have no lone pairs, angle 109.5°
NH_3 has one lone pair, angle ≈ 107°
NH_2^- has two lone pairs with greater repulsion, angle ≈ 104°
Therefore, NH_2^- has the smallest bond angle

19. **B.** 90°
Explanation: In trigonal bipyramidal PF_5, the axial bonds are perpendicular to the equatorial plane.
Therefore, the axial–equatorial bond angle = 90°

20. **D.** ClO_2
Explanation: In ClO_2, total valence electrons = $7 + 2 \times 6 = 19$, an odd number.
So one unpaired electron is present and the compound is paramagnetic.

21. **B. 12**
Explanation: In the stable Lewis structure of H_2SO_4, S has 2 S = O and 2 S − OH bonds.
Total bonding electrons = $(2 \times 4) + (2 \times 2) = 12$
Therefore, the outer shell of S holds 12 electrons

22. **A.** sp^3
Explanation: In B_2H_6, each B is attached to four H atoms (2 terminal and 2 bridging).
Therefore, steric number = 4 and hybridization is sp^3

23. **A. 4**
Explanation: In $BeCl_2$, Be forms 2 Be − Cl bonds.
Therefore, total electrons in the valence shell of Be = $2 \times 2 = 4$

24. **C. Ionic, covalent and coordinate covalent**
Explanation: Ionic bond between $[Cu(NH_3)_4]^{2+}$ and SO_4^{2-}
Covalent bonds in N − H and S − O
Coordinate covalent bond Cu ← NH_3

25. **B. Oxygen donor, carbon acceptor**
Explanation: C and O each contribute 2 electrons to form 2 covalent bonds.
In the third bond, O donates its lone pair and the vacant orbital of C accepts it.
Therefore, it is an O → C coordinate bond (oxygen donor, carbon acceptor)

26. **A. 3-centre 2-electron**
Explanation: In B_2H_6, the bridging H is attached to both B atoms (three centres).
Only 2 electrons are used in each bridge bond.
Therefore, the bond is of 3-centre 2-electron nature

27. **D. Ionic, covalent and coordinate covalent**
Explanation: Ionic bond between K^+ and $[Fe(CN)_6]^{4-}$
Covalent bond in C ≡ N
Coordinate covalent bond Fe ← CN^-

28. **D.** Cs^+
Explanation: For equal charge, the larger the radius, the lower the charge density and the lower the polarising power.
Cs^+ has the largest radius, so its polarising power is the lowest.

29. **D.** $BeCl_2$
Explanation: Be^{2+} is the smallest with the highest ionic potential, so it polarises Cl^- the most.
Therefore, $BeCl_2$ has the greatest covalent character and the lowest melting point.

30. **B.** SO_2
Explanation: SO_2 is bent (≈ 119°), so the resultant of the S = O bond moments is not zero.
Therefore, $\mu \neq 0$

31. **A.** LiI
Explanation: I^- is the largest and most easily polarised, and Li^+ has high polarising power. So LiI has the greatest covalent character and dissolves most easily in organic solvents.

32. **A.** $18e^-$ **configuration of** Ag^+
Explanation: In the pseudo-noble-gas ($18e^-$) configuration of Ag^+, d-electrons shield poorly, so the effective nuclear attraction is high.
This strongly polarises Cl^- and increases covalent character.
Therefore, the melting point of AgCl (455°C) is lower than that of KCl (770°C).

33. **C. Charge-transfer absorption by** I^-
Explanation: The large I^- is easily polarised by Pb^{2+}.
So $I^- \rightarrow Pb^{2+}$ charge transfer occurs with visible-light energy, giving PbI_2 its yellow colour.

34. **C. Weak polarising power of larger** Ba^{2+}
Explanation: Ba^{2+} is larger than Ca^{2+}, so its polarising power is lower.
As a result, CO_3^{2-} is less distorted and $BaCO_3$ needs a higher temperature to decompose.

35. **D.** $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Ba(OH)_2$
Explanation: Going down the group, the cation size increases and the lattice energy decreases faster than the hydration energy.
Therefore, solubility increases in the order $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Ba(OH)_2$

36. **B. trans isomer**
Explanation: In the trans isomer, the two C − Cl bond moments act in opposite directions with equal magnitude.
So the resultant is zero and $\mu = 0$

37. **C. Zero vector sum of bond moments**
Explanation: In trigonal planar BF_3, the 3 B − F bond moments are equal and at 120° to each other.
Their vector resultant = $\mu + 2\mu \cos 120° = 0$

38. **B.** CO_2 **and** CCl_4
Explanation: CO_2 is linear and CCl_4 is tetrahedral; both are symmetric.
The vector sum of bond moments is zero, so both molecules have zero net dipole moment.

39. **D. T-shaped**
Explanation: Steric number = $\frac{1}{2}(V + M)$
Here, $V = 7$, $M = 3$
So, steric number = $\frac{1}{2}(7 + 3) = 5$
Again, lone pairs = $5 - 3 = 2$
Therefore, the two lone pairs occupy equatorial positions, so the shape is T-shaped

40. **B. Intramolecular hydrogen bond**
Explanation: In salicylaldehyde, the −OH and −CHO groups are adjacent, so an intramolecular hydrogen bond forms.
This lowers intermolecular forces and the boiling point, making the compound steam volatile.

41. **C. Intermolecular H-bonding in the p-isomer**
Explanation: In p-nitrophenol, molecules form intermolecular hydrogen bonds with each other and with water.
In the o-isomer, an intramolecular hydrogen bond is present, so intermolecular attraction is weaker.
Therefore, the p-isomer has a higher boiling point and solubility

42. **B. Strong hydrogen bonding**
Explanation: Because of the high electronegativity of F, the H − F ⋯ H − F hydrogen bonds are strong.
The directionality of the lone pairs gives an angle of about 120°, so the chain takes a zig-zag shape.

43. **D. Partial collapse of the open cage structure**
Explanation: From 0°C to 4°C, the ice-like three-dimensional open cage structure partly collapses.
So molecules come closer together and the volume contracts.

44. **B.** $N_2 = 3.0, N_2^+ = 2.5, N_2^- = 2.5$
Explanation: Bond order = $\frac{N_b - N_a}{2}$
N_2: $\frac{10-4}{2} = 3.0$
N_2^+: $\frac{9-4}{2} = 2.5$

N_2^-: $\frac{10-5}{2} = 2.5$
Therefore, $N_2 = 3.0,\ N_2^+ = 2.5,\ N_2^- = 2.5$

45. **D. Degenerate π_{2p_x} and π_{2p_y}**
Explanation: B_2 has 10 electrons in total; by Hund's rule the last 2 electrons go one each into the degenerate π_{2p_x} and π_{2p_y} orbitals. Therefore, 2 unpaired electrons are present and the molecule is paramagnetic.

46. **B.** 3.0
Explanation: Total electrons in $NO^+ = 7 + 8 - 1 = 14$ (isoelectronic with N_2).
$N_b = 10$, $N_a = 4$
Bond order = $\frac{10-4}{2} = 3.0$

47. **A.** 1.25
Explanation: PO_4^{3-} has 1 P = O and 3 P − O bonds; total bond count = 2 + 3 = 5, shared equally among 4 bonds.
Therefore, bond order = $\frac{5}{4} = 1.25$

48. **D. Higher charge density in aluminium**
Explanation: Valence electrons of Al = 3, while Na = 1.
Al^{3+} has a higher charge and smaller size, so its charge density is higher.
Hence the metallic bond is extremely strong and the melting point (660°C) is many times that of Na (98°C).

49. **D. Free electron sea model**
Explanation: In a metallic crystal, cations are immersed in a sea of free electrons.
Even when layers of cations slide on impact, the electron sea maintains bonding, so the crystal does not break and forms sheets.

50. **A. Ionic and covalent bonds**
Explanation: Ionic bond between CH_3COO^- and Na^+
Covalent bonds C − H, C − C, C − O and C = O inside CH_3COO^-
Therefore, ionic and covalent bonds are present