VSEPR Theory

1. (c) Distorted rectangle

Explanation (Word-friendly format):
The ion $[Cu(H_2O)_4]^{2+}$ has the electronic configuration of Cu^{2+} as [Ar] $3d^9$.
Normally, a d^9 system would form an octahedral complex, but due to **Jahn–Teller distortion**, the shape becomes **distorted from the perfect octahedral geometry**.
Therefore, the actual shape of $[Cu(H_2O)_4]^{2+}$ is described as a **distorted rectangular (or distorted octahedral)** structure.

2. (a) The bond angle in PH_3 would be expected to be close to 90^o. (The bond angle $H-P-H$ in PH_3 is 93^o)

3. (b) In BF_3 molecule Boron is sp^2 hybridised so its all atoms are co-planar.

4. (c) Due to $lp-lp$ repulsions, bond angle in H_2O is lower ($104^o.5'$) than that in NH_3 (107^o) and CH_4 ($109^o28'$). BeF_2 on the other hand, has *sp*-hybridization and hence has a bond angle of 180^o.

5. (c) Compound is carbontetrachloride because CCl_4 has sp^3 – hybridization 4 orbitals giving regular tetrahedron geometry. In others the geometry is little distorted inspite of sp^3 hybridization due to different atoms on the vertices of tetrahedron.

6. (b) SO_4^{2-} ion is tetrahedral since hybridization of *S* is sp^3.

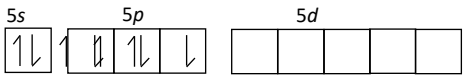
7. (b) NH_3 molecule has one lone pair of electrons on the central atom *i.e.* Nitrogen.

8. (c) C_2H_2 has linear structure because carbons are *sp*-hybridised and lies at 180^o.

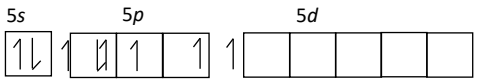
9. (b) XeF_6 is distorted Octahedral. It has sp^3d^3 hybridisation with lone pair of electron on *Xe*, so its shape is distorted.

10. (a)

11. (c) *Xe* ground state

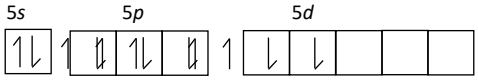


Xe double excitation



XeF_4

sp^3d^2 - hybridization



12. (a) CO_2 has bond angle 180^o.

13. (a) As the *s*-character of hybridized orbitals decreases the bond angle also decreases
In sp^3 hybridisation: *s*-character 1/4, bond angle 109^o
In sp^2 hybridisation: *s*-character 1/3, bond angle 120^o
In *sp* hybridisation: *s*-character 1/2, bond angle 180^o

14. (a) XeF_2 molecule is Linear because *Xe* is *sp* hybridised.

15. (c) SO_4^{2-} has 42 electrons; CO_3^{2-} has 32 electrons; NO_3^- has 32 electrons

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16. (c) Molecular oxygen contains unpaired electron so it is paramagnetic (according to MOT).

17. (b) Structure of H_2O is a bent structure due to repulsion of lone pair of oxygen.

18. (d) Bond angle between two hybrid orbitals is 105^o it means orbitals are sp^3 hybridised but to lone pair repulsion bond angle get changed from 109^o to 105^o. So its % of *s*-character is between 22-23%.

19. **(d) 105°**

Explanation (Word-friendly format):
In ice (solid water), each oxygen atom is tetrahedrally surrounded by four hydrogen atoms through two covalent and two hydrogen bonds.

Because of hydrogen bonding, the **H–O–H bond angle** slightly decreases from the 109.5° tetrahedral angle, becoming approximately **105°** .

20. **(a) H_2S**

Explanation:

H_2S has a **bent (V-shaped)** structure due to the presence of two lone pairs on sulfur, causing bond pair–lone pair repulsion.

Other molecules (C_2H_2, BeH_2, CO_2) are **linear** because they have no lone pairs on the central atom and all bonding is in a straight line.