UNIT 4

CHEMICAL BONDING AND MOLECULAR STRUCTURE

Answer the questions. (1 Score each)

1. Predict the shape of XeF_4 molecule, according to VSEPR theory

Ans: XeF_4 contains 6 VSEPs, out of them 4 are bond pairs and 2 are lone pairs of electrons. So the shape is square planar

2. The hybridization of C in ethene is ....

Ans: sp^2

3. Give the shape of the following species. i) NH_4^+ ii) $HgCl_2$

Ans: i) NH_4^+ - Tetrahedral ii) $HgCl_2$ - Linear

4. The geometry of SF_6 molecule is ……..

Ans: Octahedral

5. One-half of the difference between the number of electrons in the bonding and antibonding molecular orbitals is called …………..

Ans: Bond order

6. A molecule of the type AB_4E has 4 bond pairs of electrons and one lone pair of electron. Predict the most stable structure of this compound.

Ans: See-saw shape

Answer the questions. (2 Score each)

7 . Find the bond order of H_2 molecule

Ans: M.O configuration of H_2 is $\sigma 1s^2$

Bond order (B.O) = ½ [$N_b - N_a$] = ½ [2 – 0]
= ½ x 2 = 1

Answer the questions. (3 Score each)

8. Write the molecular orbital electronic configuration of He_2 and O_2 molecules. Compare the stability and magnetic behaviour of these molecules on the basis of M.O. theory.

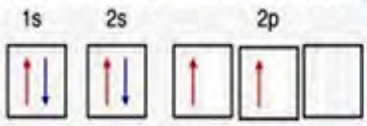
Ans: He_2 molecule contains 4 electrons
Its M.O configuration is:
$\sigma 1s^2\ \sigma^* 1s^2$
O_2 molecule contains 16 electrons
Its M.O configuration is:
$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2\ \pi^* 2p_x^1\ \pi^* 2p_y^1$

Bond order (B.O) = ½ [$N_b - N_a$]
For He_2, B.O = ½ [2 – 2] = 0
For O_2, B.O = ½ [10 – 6] = ½ x 4 = 2
Since O_2 has higher bond order than He_2, it is more stable. He_2 is not stable while O_2 is paramagnetic due to the presence of unpaired electrons.

9. Explain sp^3 hybridisation taking methane (CH_4) as an example.

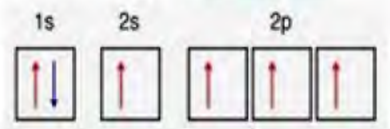
Ans: In CH_4 , the central atom C has the electronic configuration $1s^2\ 2s^2\ 2p^2$

C (Ground state) -

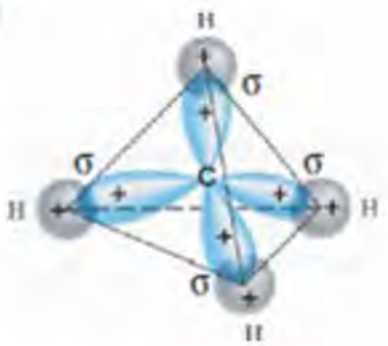


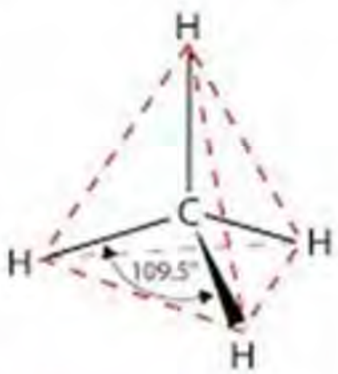
In order to explain the tetra valency of Carbon, it is suggested that one of the electrons of 2s orbital is promoted to 2p orbital.

C (excited state) –



Now, one s-orbital and three p-orbitals undergo sp^3 hybridisation. These sp^3 hybrid orbitals are directed to the four corners of a regular tetrahedron with bond angle 109^0 28' . Each of these sp^3 hybrid orbitals overlap with 1s orbital of H to form four C-H σ bonds.





<u>**Answer the questions. (4 Score each)**</u>

10. VSEPR theory is used to predict the shape and bond angle of molecules.
Write the postulates of VSEPR theory.

Ans: The important postulates of this theory are:

i) The shape of the molecule depends on the no. of valence shell electron pairs around the central atom

ii) The valence shell electron pairs repel each other.

iii) In order to reduce the repulsion, the electron pairs stay at maximum distance.

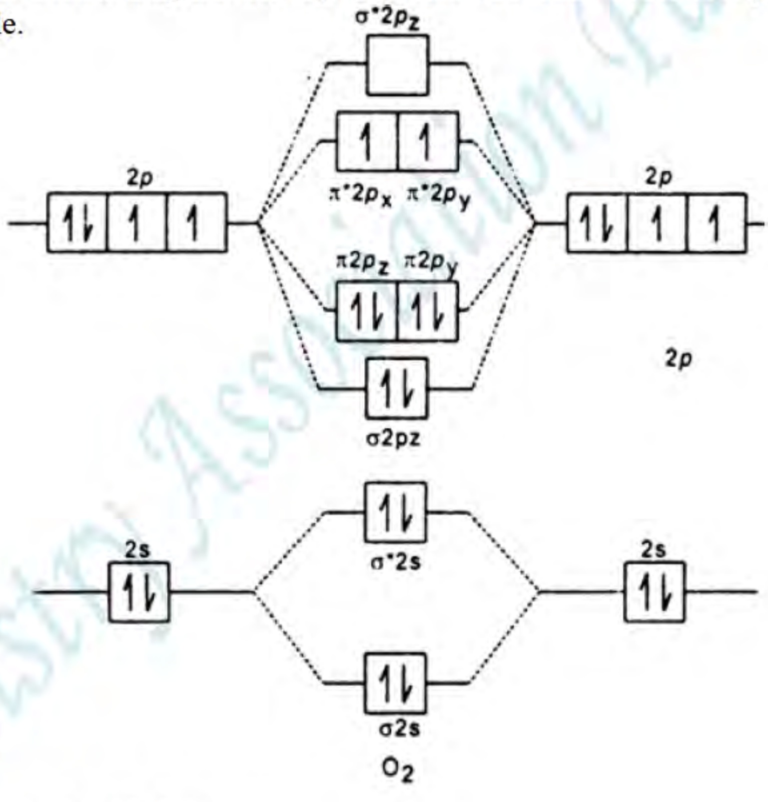
iv) Presence of lone pairs of electron causes distortion in the expected geometry of the molecule.

v) The repulsion between two lone pairs of electrons is different from those between two bond pairs or between a lone pair and bond pair. The repulsion decreases in the order lone pair - lone pair > lone pair – bond pair > bond pair - bond pair.

vi) As the angle between the electron pairs increases, the repulsion decreases

11. Draw the molecular orbital diagram for O_2. Calculate the bond order and predict the magnetic character of O_2 molecule.

Ans:



O_2 molecule contains 16 electrons

Its M.O configuration is:

$\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2\ \pi^*2p_x^1\ \pi^*2p_y^1$

Bond order (B.O) = ½ $[N_b – N_a]$

For O_2, B.O = ½ [10 – 6] = ½ x 4 = 2

O_2 is paramagnetic due to the presence of unpaired electrons.