Chemistry

1) what is meant by hybridization?

Ans:

(i) It is defined as the concept of mixing two atomic orbitals to give rise to a new type of hybridized orbitals.

(ii) Hybridisation increases the stability of bond formation than unhybridised orbitals.

(iii) Hybridisation occurs during bond formation not in isolated system.

(iv) We can predict the shape of molecules by its hybridisation.

(v) Example

Formation of Methane (CH_4) involves a combination of three p orbital of carbon (C) and one s orbital of Hydrogen (H) to form sp^3 ~~hybrized~~ hybridized orbitals and a tethrahedral geometry.

(3) CH_4, NH_3 and H_2O have tetrahedral geometry yet their bond angles are different. Why?

Ans:

All they have the same tetrahedral geometry but shape is different because of presence of lone pairs of electron. Hybridization of molecules depends both on lone pairs of electron and sigma bond.

The bond angles in CH_4 (109.5°), NH_3 (107°) and H_2O (104.5°) are different although these molecules have the same

hybridization, sp^3.

In CH_4, the central atom is C which is in sp^3 hybridization state. The four H-atoms are situated at the four corners of the tetrahedron. The bond angle between H-C-H is 109.5° which is called the ~~tetrahedral~~ tetrahedral angle.

But in the case of NH_3 and H_2O molecules, their central atoms N and O have a lone pair of electrons. Their lone pair causes repulsion of electrons and hence causes the decrease in the normal tetrahedral angle which gets reduced to 107° in NH_3 and 104.5 in H_2O.

(4) Explain the structure of the following molecules on the basis of hybridization:

~~sp~~

SF_4. SF_6. PCl_5. PCl_3

SF_4:

SF_4 Molecular Geometry and Bond Angles. $Z = \frac{1}{2}(6 + 4) = 5$

SF_4 molecular geometry is see-saw with one pair of valence electron. these atoms form a trigonal bipyramidal shape. The equatorial fluorine atoms have 102° bond angles instead of the actual 120° angle.

Shape - sp^3d

SF_6:

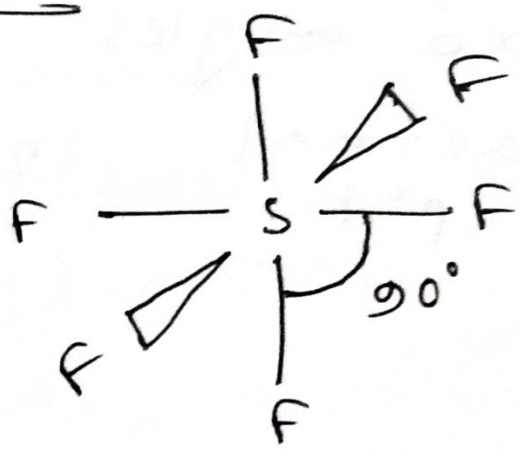
SF_6 both axial bonds and equatorial bonds have the same bond length.

In SF_6 central atom sulphur undergoes sp^3d^2 hybridization so that it has octahedral geometry. ~~Sulfe~~ ~~sp-sp~~ SF_6 has 6 regions of electron. The resulting shape is an octahedron with 90° F-S-F bond angles.

$$\text{Z} = \frac{1}{2}(6+6) = 6$$

$$= sp^3d^2$$

Pcl$_5$:

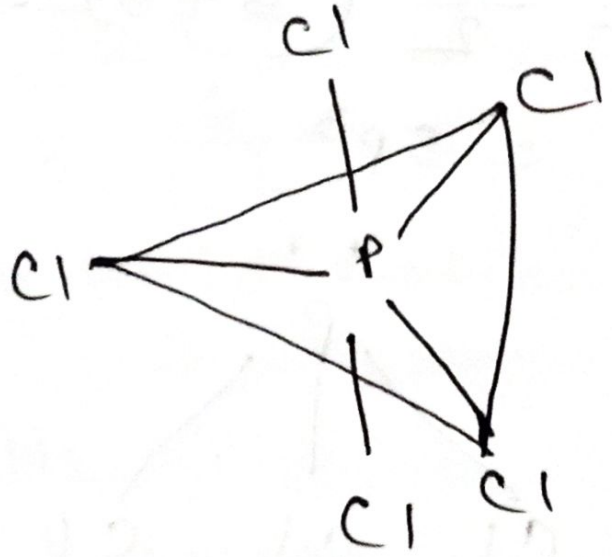


PCl_5:

The hybridization in phosphorus pentachloride is sp^3d and it has a trigonal bipyramidal geometry in gaseous and liquid states. It has two axial P-Cl bonds and three equatorial P-Cl bonds.

$$Z = \frac{1}{2}(5+5) = 5$$

$$= sp^3d$$



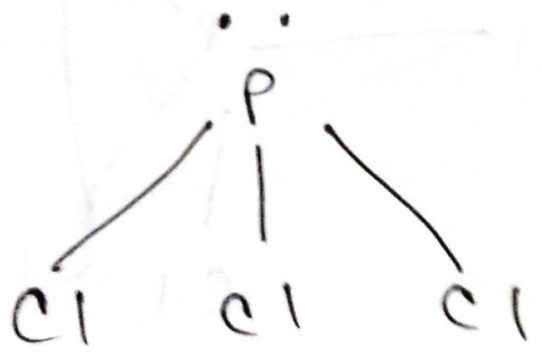
Trigonal ~~by~~ bipyrami

PCl_3 :

PCl_3 have pyramidal geometry. In PCl_3, three sp^3 hybrid orbitals of phosphorus overlap with ~~the~~ p-orbitals of chlorine to form three P-Cl sigma bonds while the forth sp^3 hybrid orbital contains lone pair of electrons.

$$Z = \frac{1}{2}(5+3) = 4$$

$$= sp^3$$



pyramidal

(2) Describe sp^3. sp^2 and sp hybridization of carbon in organic molecules below:

CH_4, C_2H_4, C_2H_2, C_6H_6

Ans:

CH_4

$$z = \frac{1}{2}(4+4) = 4$$

Hybridization $= sp^3$

C_2H_4

$$z = \frac{1}{2}(2+4)$$

$$= \frac{6}{2} = 3$$

Hybridization $= sp^2$

C_2H_2

$$z = \frac{1}{2}(2+2)$$

$$= \frac{4}{2}$$

$$= 2$$

Hybridization $= sp$

C_6H_6

$$2 = \frac{1}{2}(6+6)$$

$$= \frac{12}{2}$$

$$= 6$$

Hybridization $= sp^3d^2$