CHEMISTRY

(FOR IIT, NEET, AIIMS)

Class – XI

Unit 4 : Chemical Bonding

Topic : Hybridization involving d-orbitals

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(4) sp^3d- Hybridization

- "The process in which one-s, three-p and one-d orbitals of nearly same energy, mixed together by redistribution of energy and form five new orbitals of exactly same energy and same shape is called sp^3d hybridization and new orbitals formed are called sp^3d - hybridized orbitals."

- Here, three sp^3d-hybridized orbitals remain directed towards three corners of an equilateral triangle and lie in same plane at an angle of 120^0. These orbitals are called **equatorial orbitals**.
- The remaining two sp^3d-orbitals lie perpendicularly above and below the plane formed by equatorial orbitals and are called **axial orbitals**.

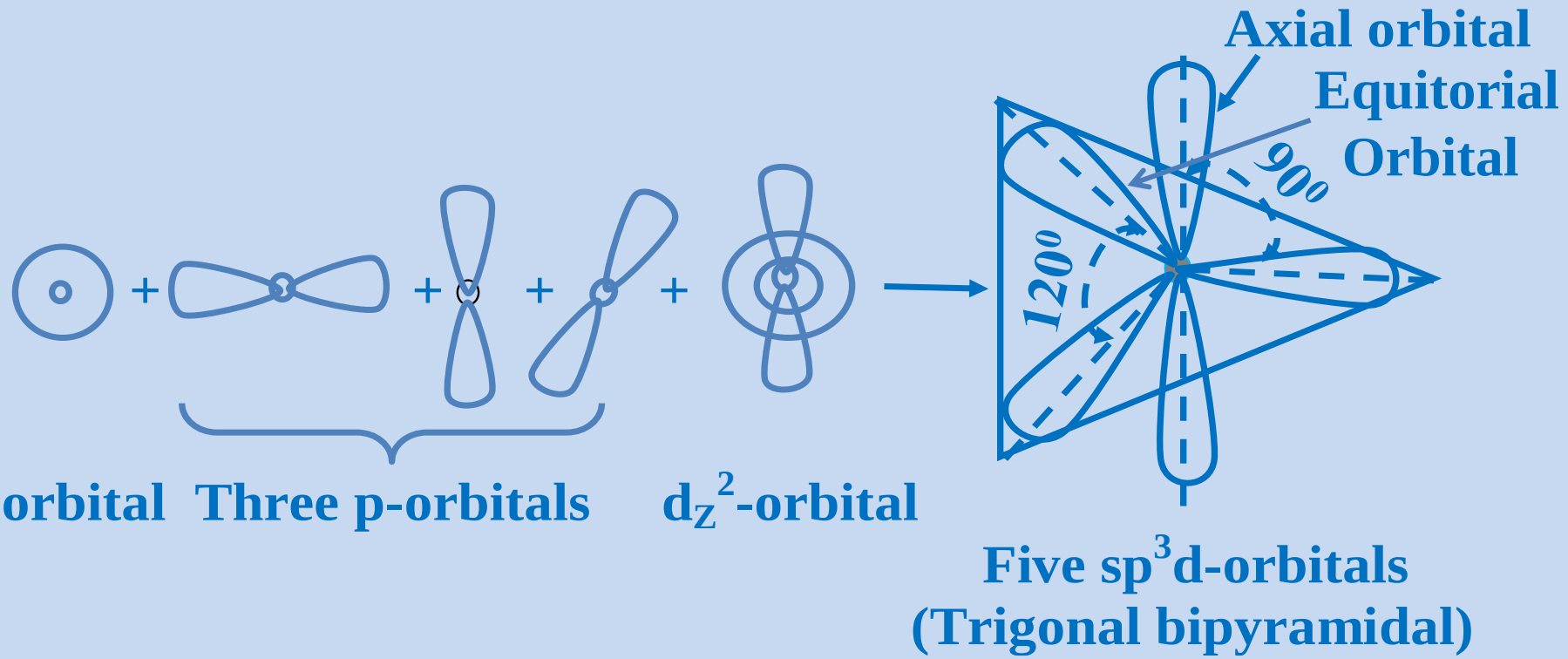


Fig.- sp^3d- Hybridization

- Thus, sp^3d hybridization provides trigonal bi-pyramidal shape to the molecules with a bond angle of 120^0 and 90^0. Hence, it is also called **trigonal bi-pyramidal hybridization.**
- **Example- Formation of PCl_5 molecule.**
- The electronic excitation and sp^3d hybridization in central phosphorus atom, leading to the formation of PCl_5 molecule can be represented as follows-

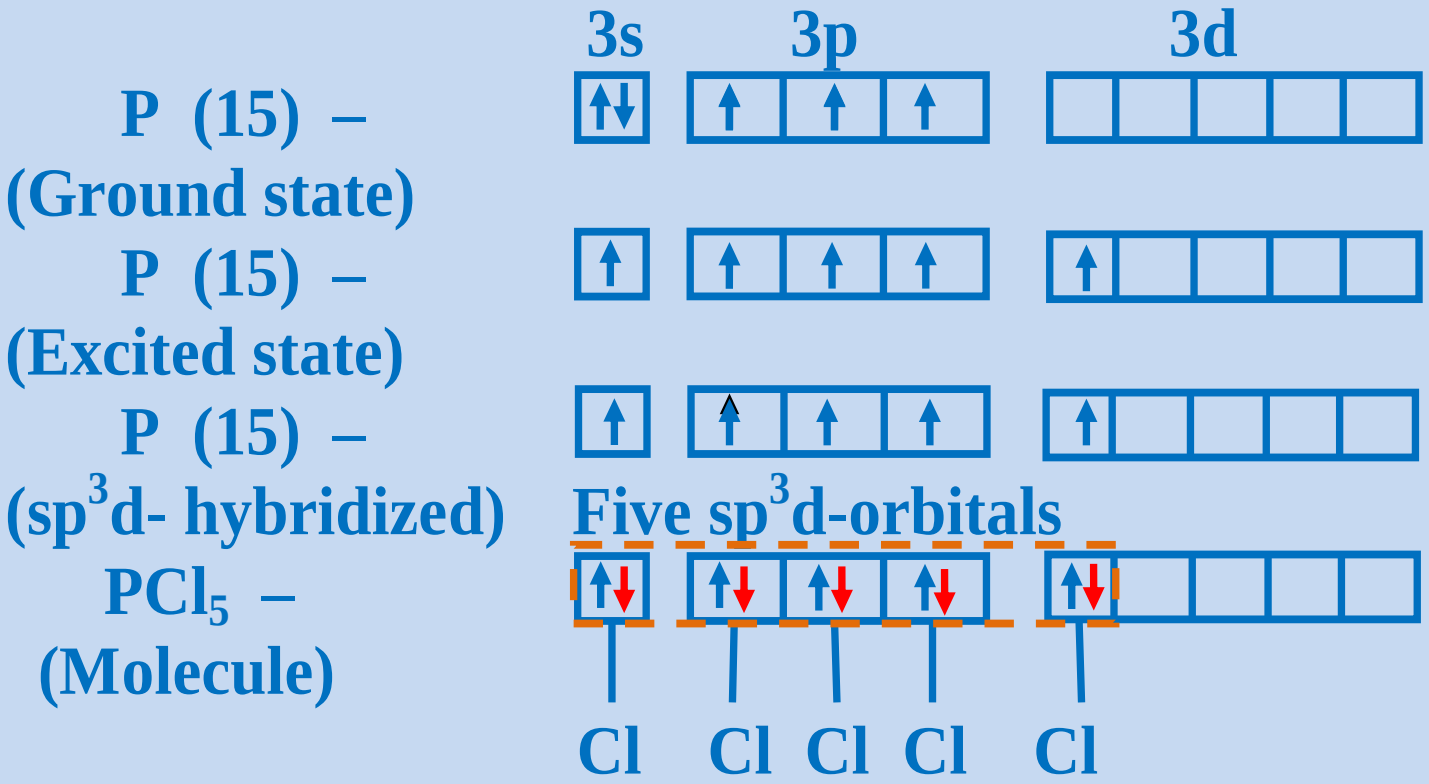


Fig.- Formation of PCl_5 molecule (schematic)

- Since, PCl_5 molecule involves sp^3d hybridization, it is trigonal bi-pyramidal in shape with a bond angle of 120^0 and 90^0.

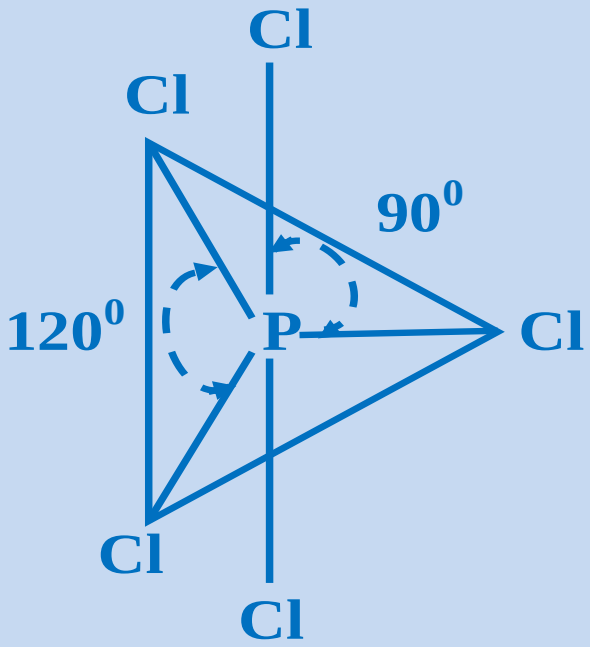


Fig.- PCl_5 molecule (trigonal bi-pyramidal)

(4) sp^3d^2- Hybridization

- "The process in which one-s, three-p and two-d orbitals of nearly same energy, mixed together by redistribution of energy and form six new orbitals of exactly same energy and same shape is called sp^3d^2 hybridization and new orbitals formed are called sp^3d^2 hybridized orbitals."

- Here, sp^3d^2 -hybridized orbitals remain directed towards six corners of a regular octahedron and lie at an angle of 90^0.
- Thus, sp^3d^2 hybridization provides octahedral shape to the molecules with a bond angle of 90^0. Hence, it is also called **octahedral hybridization.**

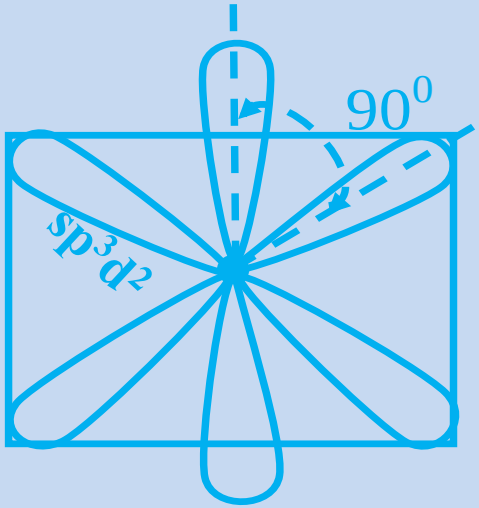


Fig.- Six sp^3d^2- Hybridized orbitals (Octahedral)

- **Example- Formation of SF_6 molecule.**
- The electronic excitation and sp^3d^2 hybridization in central sulphur atom, leading to the formation of SF_6 molecule can be represented as follows-

S (16) – (Ground state)

S (16) – (I^{st} Excited state)

S (16) – (II^{nd} Excited state)

S (16) – (sp^3d^2- hybridized)

SF_6 – (Molecule)

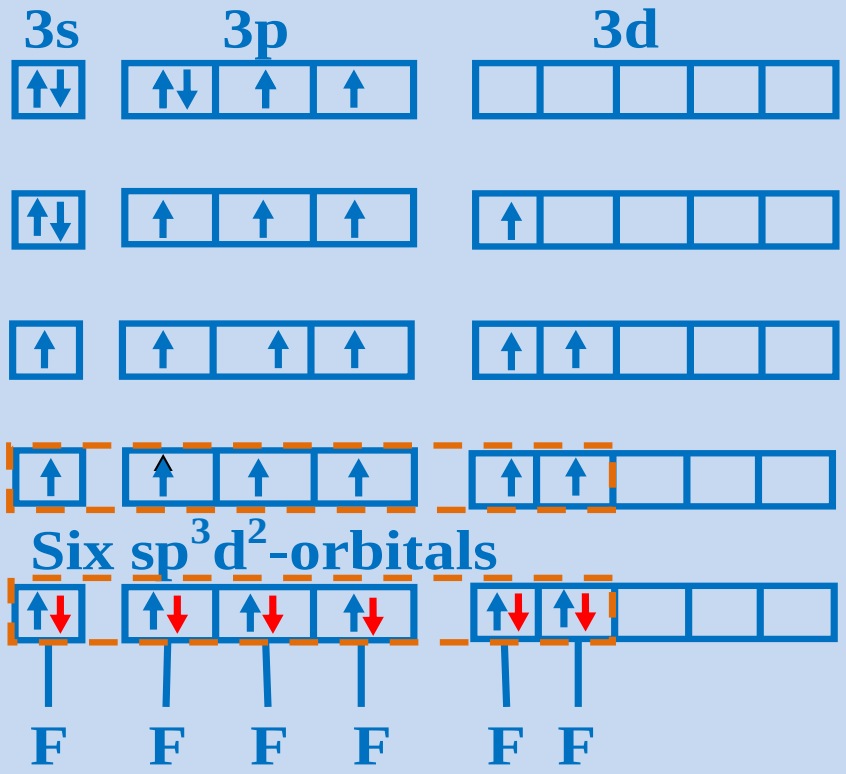


Fig.- Formation of SF_6 molecule (schematic)

- Since, SF_6 molecule involves sp^3d^2 hybridization, it is octahedral in shape with a bond angle of 90^0.

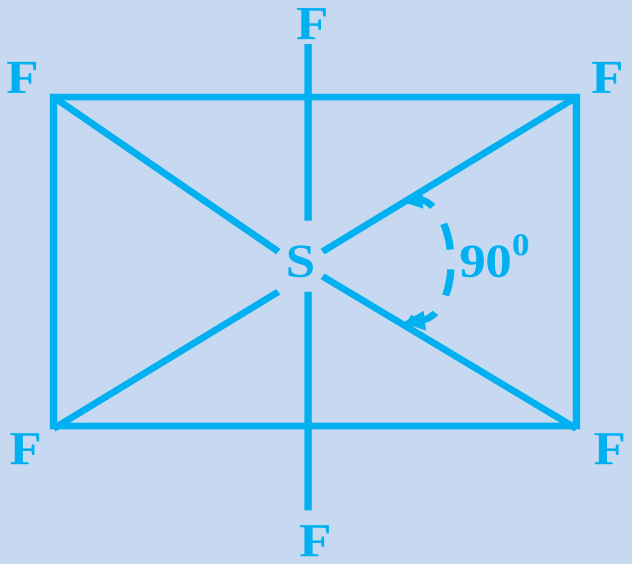


Fig.- SF_6 molecule (octahedral)

➢ Important Facts for IIT, NEET, AIIMS-

- ➢ sp^3d hybridization provides trigonal bipyramidal shape to the molecules with a bond angle of 120^0 and 90^0.
- ➢ sp^3d hybridization is also called **trigonal bipyramidal hybridization.**
- ➢ d-orbital involved in sp^3d hybridization- dz^2.

- sp^3d^2 hybridization provides octahedral shape to the molecules with a bond angle of 90^0.
- sp^3d^2 hybridization is also called **octahedral hybridization.**
- d-orbitals involved in sp^3d^2 hybridization- Axial d-orbitals (dx^2-y^2 and dz^2).
- sp^3d^3 hybridization provides pentagonal bipyramidal shape to the molecules with a bond angle of $72^0$and 90^0. Example- IF_7 molecule

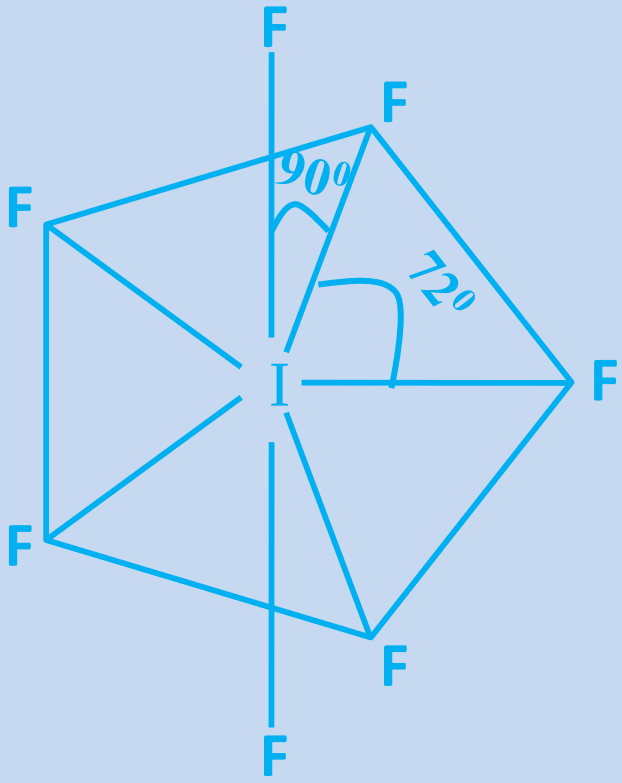


Fig.- IF_7 molecule (pentagonal bipyramidal)

- sp^3d^3 hybridization is also called **pentagonal bipyramidal hybridization.**
- d-orbitals involved in sp^3d^3 hybridization- Non-axial d-orbitals (dxy, dyz and dxz).
- d-orbital involved in dsp^2 hybridization- dx^2-y^2

THANKS

for

WATCHING