

220
AUGUST

०४ भाद्रपद कृष्ण, शुक्रवार, सं० २०७७

Dr. Sanjay Kumar Yadav

Lecture Notes Series: -15

[4] sp^3d Hybridisation [Trigonal bipyramidal Hybridisation]

The Mixing of 's', three p- and one d-orbitals to form five sp^3d hybrid orbitals is called sp^3d hybridisation and the resulting hybrid orbitals are called Trigonal bipyramidal hybrid orbitals.

Properties. All these five hybrid orbitals are not equivalent. These can be divided into two sets.

(i) Equatorial hybrid orbitals: - This set consists of three equivalent hybrid orbitals which are directed towards the corners of an equilateral triangle. Thus these are planar and the angle between them is 120° . This set is known as equatorial or basal or planar hybrid orbitals.

(ii) Axial hybrid orbitals: - This set consists of two equivalent hybrid orbitals which are perpendicular to the plane of equatorial hybrid orbitals. These make an angle of 180° with each other but with equatorial orbitals they make an angle of 90° . This set is known as axial or polar hybrid orbitals.

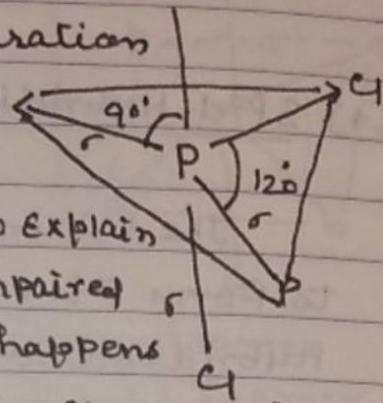
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					



[Formation of PCl_5]

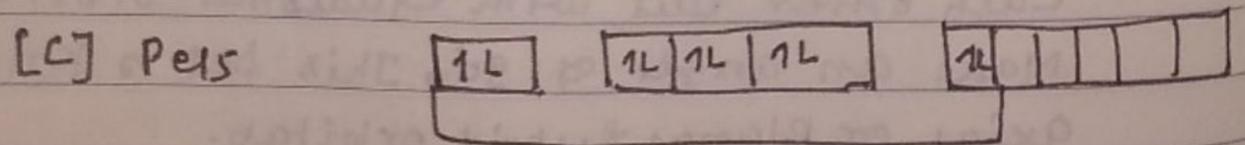
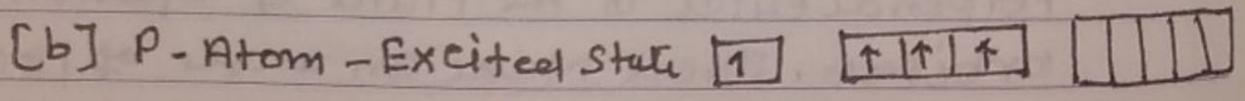
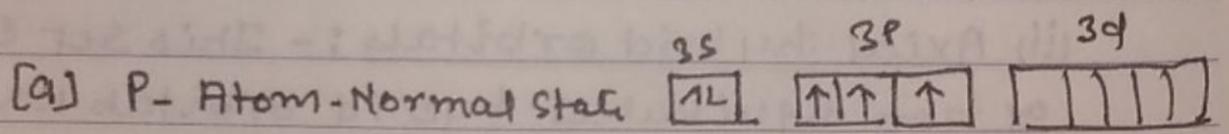
04 भाद्रपद कृष्ण, शनिवार, सं० २०७७

In PCl_5 Molecule, the central atom Cl is P whose electronic configuration is ground state $1s^2, 2s^2, 2p^6, 3s^2, 3p_x^1, 3p_y^1, 3p_z^1$. It has



three unpaired electrons. To explain the formation of PCl_5 , five unpaired electrons are required. This happens under excited state when one electron from 3s orbital is promoted to vacant 3d-orbitals. These five atomic orbitals now undergo sp^3d hybridisation to form five sp^3d hybrid orbitals which are singly occupied. These singly occupied sp^3d hybrid orbitals overlap with five singly filled 3p atomic orbitals of 5 Cl-atoms to form five P-Cl sigma bonds. Thus PCl_5 molecule has a trigonal bipyramidal structure as shown in above figure.

रविवार/SUN 09 The molecules PF_5, ClF_5 etc, also trigonal bipyramidal structure.



sp^3d

[sp^3d Hybridisation in PCl_5]

First they ignore you, then they laugh at you, then they fight you, then you win.

[5] sp^3d^2 Hybridisation

WK-33

MONDAY

[Octahedral Hybridisation]

The mixing of 's', three p- and two d- atomic orbitals to form six equivalent sp^3d^2 hybrid orbitals is known as sp^3d^2 hybridisation.

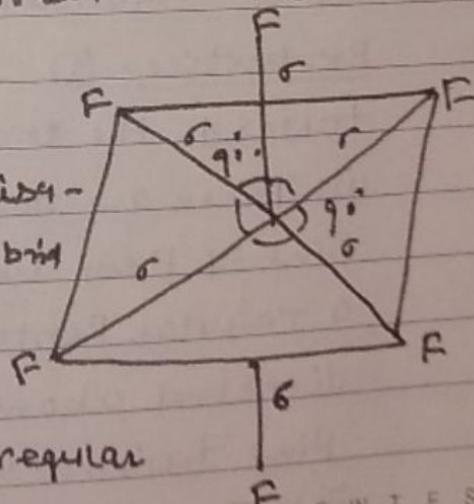
- Properties
- (i) These hybrid orbitals are directed towards the six corners of a regular octahedron
 - (ii) Four out of six hybrid orbitals are lying in one plane while the remaining two are directed above and below the plane containing the four hybrid orbitals perpendicularly.

(iii) The angle between the hybrid is 90°

Example [Formation of SF_6]

In SF_6 molecule, the central atom S whose electronic configuration in ground state is $1s^2, 2s^2, 2p^6, 3s^2, 3p_x^2, 3p_y^1, 3p_z^1$. It contains two unpaired electrons. To explain the formation of SF_6 , six unpaired electrons are required. This happens under excited state when one electron each from 3s and 3p_x orbitals is promoted to vacant d-orbitals.

These six orbitals now undergo sp^3d^2 hybridisation to form six sp^3d^2 hybrid orbitals which are singly occupied and directed towards the six corners of a regular octahedron.



These singly

S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
.	.	.	.	.	.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	.	.	.	.	.

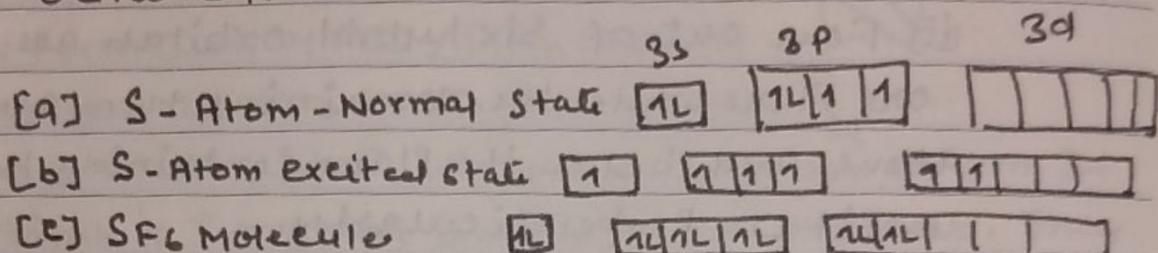


hybrid orbitals overlap with ¹⁰भद्रपद कृष्ण, मंगलवार, सं० २०१७

Six singly filled $2p_z$ atomic orbitals of 6 F-atoms to form six S-F sigma bonds. Thus SF_6

molecule has a regular octahedral shape.

The ions AlF_6^{2-} , SiF_6^{2-} , PF_6^- etc. also have octahedral shape.



sp^3d^2 Hybridisation [Octahedral]

sp^3d^2 Hybridisation in SF_6

[6] sp^3d^3 Hybridisation [Pentagonal bipyramidal Hybridisation]

The mixing of one s -, three p - and three d - atomic orbitals to form seven equivalent sp^3d^3 hybrid orbitals is known as sp^3d^3 hybridisation.

Properties. (i) The sp^3d^3 hybrid orbitals are directed towards the corners of a pentagonal bipyramid.

(ii) These are not equivalent hybrid orbitals because five of them are directed towards the corners of a regular pentagon while the remaining two are directed above and below the plane containing the five hybrid orbitals perpendicularly.

(iii) The bond angle between them is 72° and 90°

2020
AUGUST

०८ भाद्रपद कृष्ण, बुधवार, सं० २०७९

Page - 5

WK-33

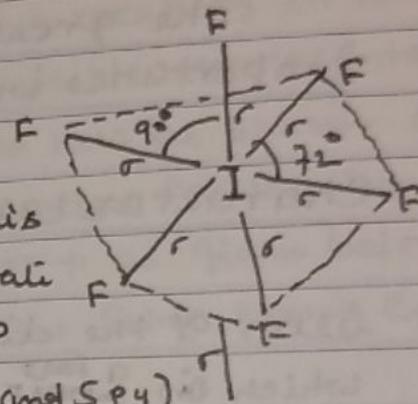
12

Example - (Formation of IF_7)

225-141 | WEDNESDAY

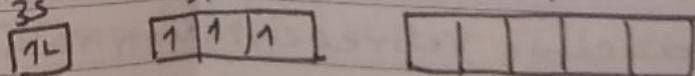
In IF_7 Molecule, the central atom is I whose outer electronic configuration in ground state is $5s^2, 5p_x^2, 5p_y^2, 5p_z^1$. It contains only one unpaired electron.

To explain the formation of IF_7 , Seven unpaired electrons are required. This happens under excited state when one $5s$ and two $5p$ (ie one each from $5p_x$, and $5p_y$)

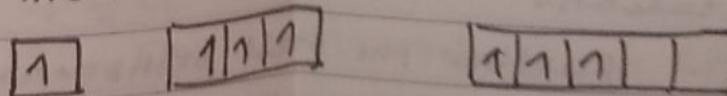


electrons are Promoted to $5d$ orbitals. These seven atomic orbitals then hybridise to form seven sp^3d^2 hybrid orbitals which are singly filled. These orbitals overlaps with singly filled $2p_z$ atomic orbitals of 7 F-atom to form I-F sigma bonds. Thus IF_7 molecule has Pentagonal bipyramidal shape shown in above figure.

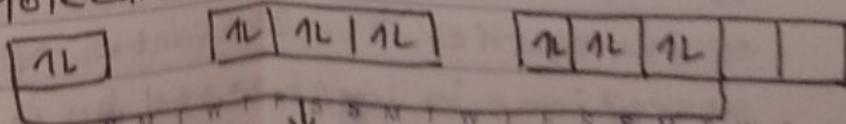
(a) I-Atom Normal state



(b) I-Atom excited state



(c) IF_7 Molecule



sp^3d^2 Hybridisation

[Pentagonal Bipyramidal]

sp^3d^2 Hybridisation in IF_7