

Hybridisation [Continue]

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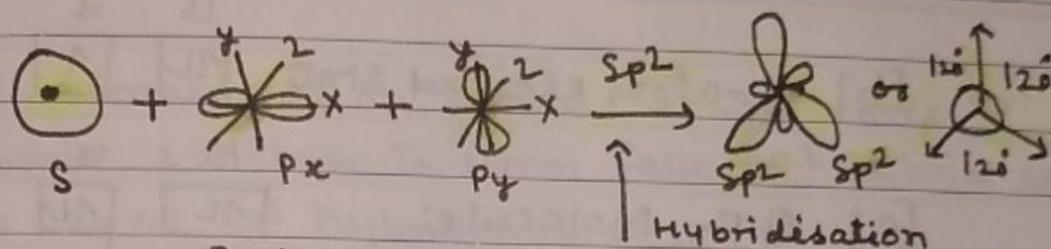
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Dr. Sanjay Kumar Yadav

Lecture Notes Series: -(2.) sp^2 -Hybridisation [Trigonal Hybridisation]

The combination of 's' - and two 'p' atomic orbitals to form three sp^2 hybrid orbitals is called sp^2 -hybridisation.

[sp^2 -hybridisation [Trigonal]]Properties of sp^2 -Hybridisation

- (i) All the three sp^2 hybrid orbitals are equivalent in shape and energy.
- (ii) The three sp^2 -hybrid orbitals lie in the same plane (co-planar) and are directed towards three corners of an equilateral triangle having an angle of 120° .
- (iii) The ratio of p-character to s-character is 2:1 in each of sp^2 hybrid orbitals.

Example [Formation of BF_3 Molecule]

In BF_3 Molecule, the central atom is B whose electronic configuration

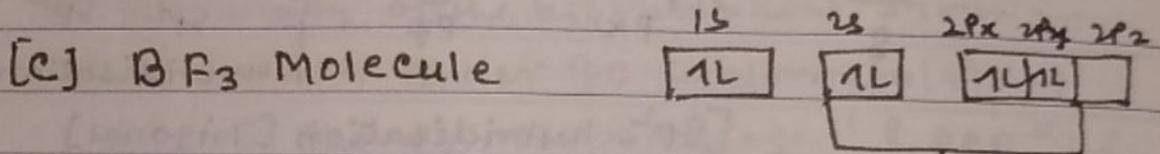
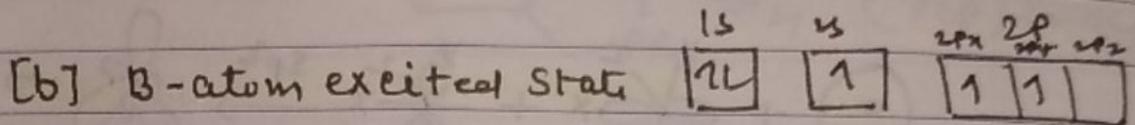
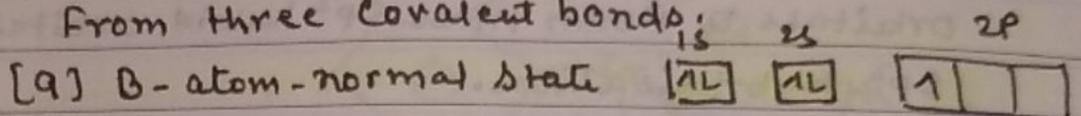
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
-	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	-	-	-	-	-	-	-	-



is $1s^2, 2s^2 2p^1$, The B-atom

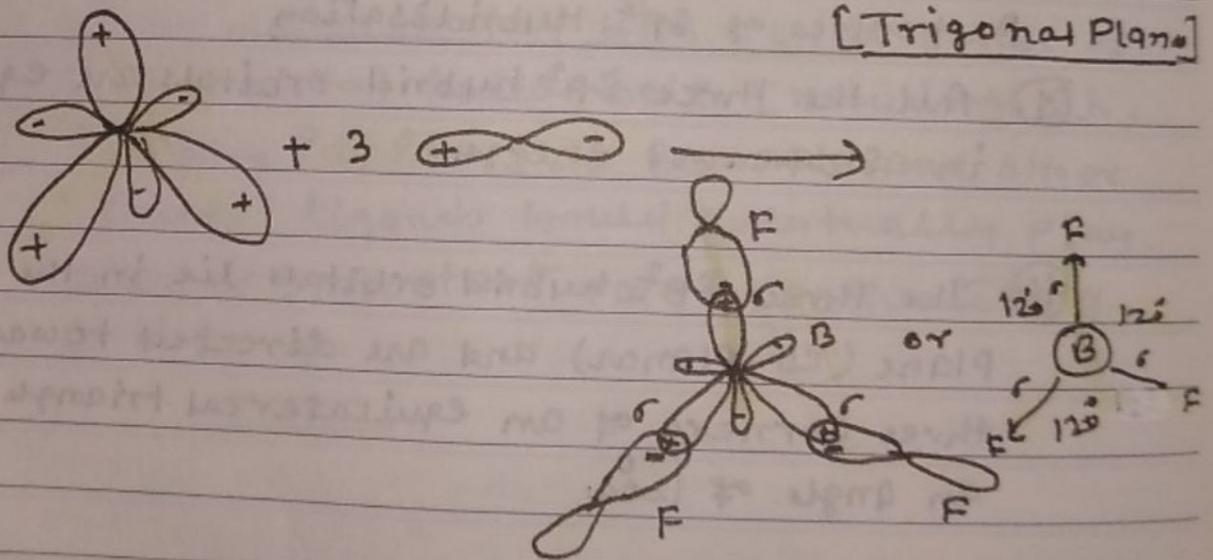
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has only one unpaired electron so that it can form only one covalent bond. Under excited state, its electronic configuration is $1s^2, 2s^1 2p_x^1 2p_y^1 2p_z^0$ giving three unpaired electrons to form three covalent bonds.



sp² hybridisation

[Trigonal Planar]



These three atomic orbitals then hybridize to form three sp² hybrid orbitals which are singly occupied and directed towards the three corners of an equilateral triangle. Each of these hybrid orbitals overlaps with singly filled 2p_z atomic orbitals of 3 F-atoms.

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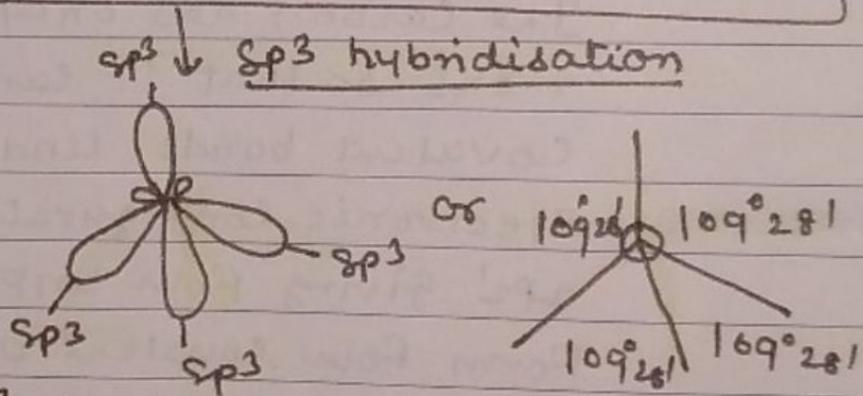
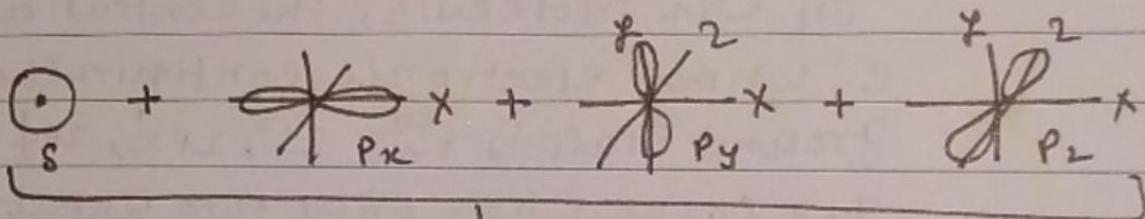
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$[Fq = 1s^2, 2s^2, 2p_x^2, 2p_y^2, 2p_z^1]$ to form three B-F sigma bonds. These bonds are co-planar and are at 120° to each other. Thus BF_3 molecule has trigonal planar shape. Similar are the structures BCl_3, BH_3 etc molecules.

[3] sp^3 -Hybridisation [Tetrahedral Hybridisation]

The combination of one 's' and three 'p' atomic orbitals to form four sp^3 hybrid orbitals is called sp^3 hybridisation.



[sp^3 -Hybridisation (Tetrahedral)]

Properties of sp^3 hybrid orbitals

- ①. All the four sp^3 -hybrid orbitals are equivalent in shape and energy.

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



sp^3 hybrid orbitals are directed towards the four corners of a regular tetrahedron whose centre is occupied by the atom that has undergone hybridisation.

(iii) The angle between hybrid orbitals is 109.28°

(iv) sp^3 hybrid orbitals are the strongest compared to sp and sp^2 hybrid orbitals.

Example [Formation of CH_4 Molecule]

In CH_4 molecule, the central atom is C whose electronic configuration in ground state is $1s^2, 2s^2, 2p_x^1, 2p_y^1, 2p_z^0$.

The carbon has only two unpaired electrons so that it can form only two covalent bonds. Under excited state, its electronic configuration is $1s^2, 2s^1, 2p_x^1, 2p_y^1, 2p_z^1$ giving four unpaired electrons to form four covalent bonds.

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These four atomic orbitals then hybridise to form four equivalent sp^3 hybrid orbitals which are singly filled and directed towards the four corners of a regular tetrahedron with C-atom at the centre. Each of these four hybrid orbitals overlaps with singly filled $1s$ -orbitals of 4 H-atoms ($H_1 = 1s^1$) to form

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C-H Sigma bonds

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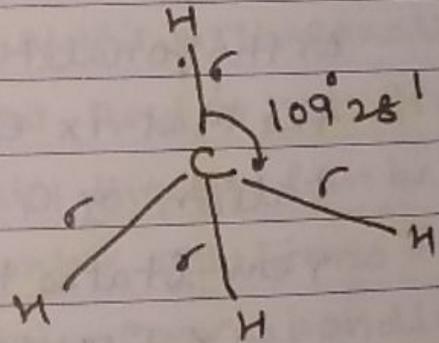
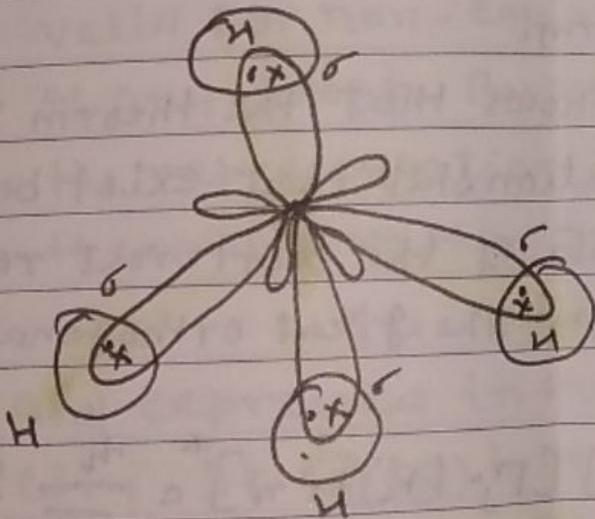
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The angle between the bonds is $109^{\circ}28'$

Thus CH₄ molecule has a tetrahedral shape with a bond angle equal to $109^{\circ}28'$

	1s	2s	2p _x	2p _y	2p _z
(a) C-atom normal state -	1L	1L	1	1	1
(b) C-atom excited state -	1L	1	1	1	1
(c) CH ₄ molecule	1L	1L	1L	1L	1L

↓
sp³ hybridisation [Tetra-
hedral]



[sp³ Hybridisation in CH₄]

[Rest Part Next Pdf]