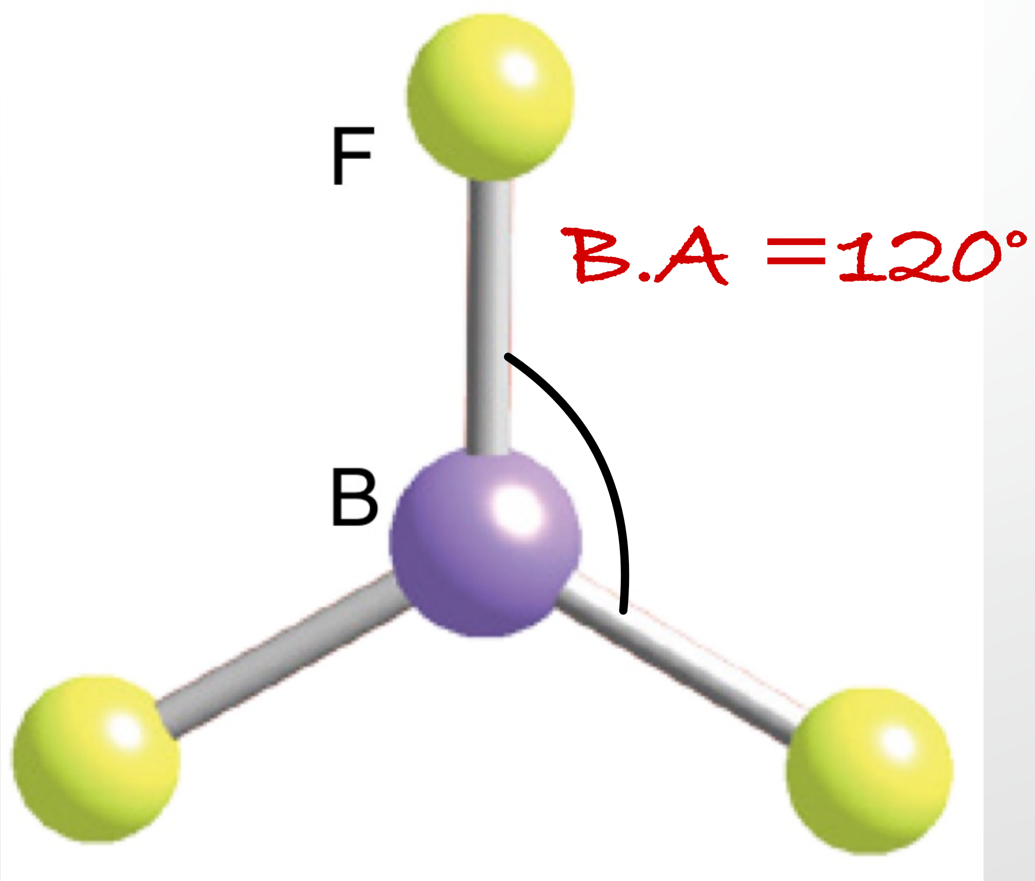
(Q) Apply concept of hybridisation in BF_3 (g) molecule

Ans:) S.N = No of σ bond + No. of lp (CA)

= 3 + 0

=



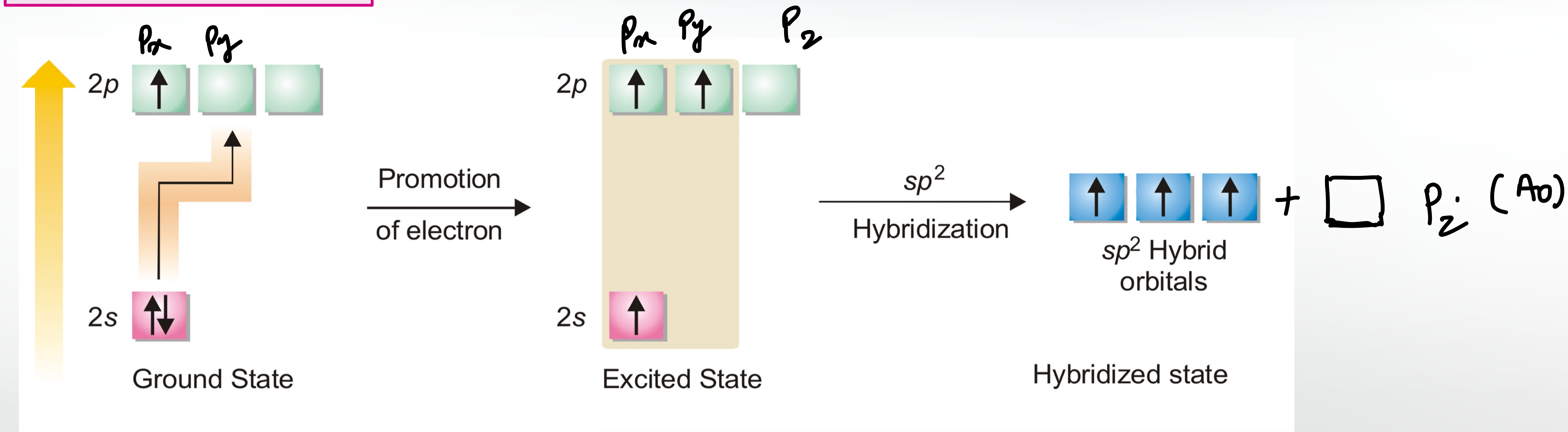
Shape: Trigonal planner

Max. Number of atom in one plane = 4

Planar molecule

Hybridisation :Sp2

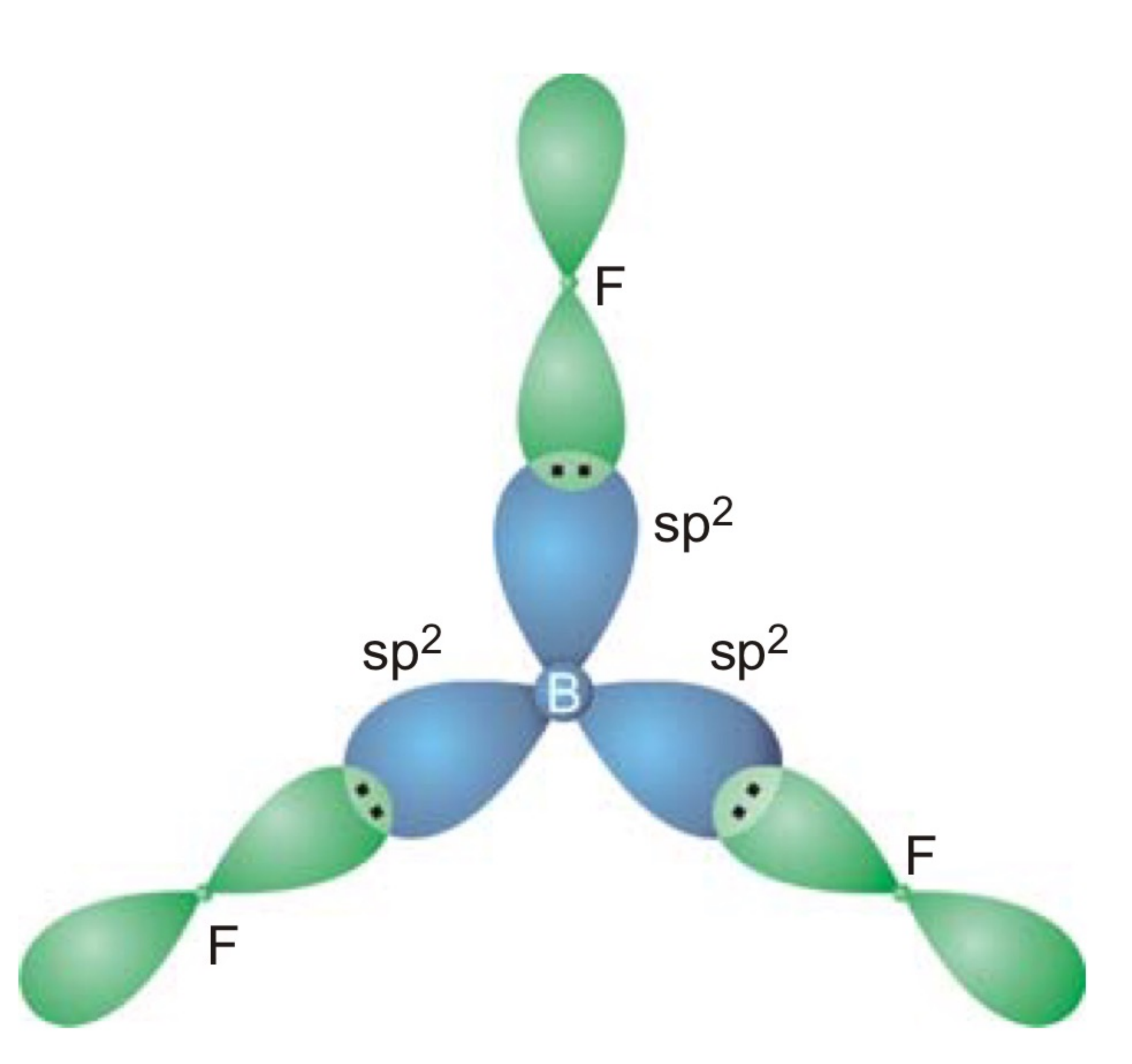
Chemical Bonding

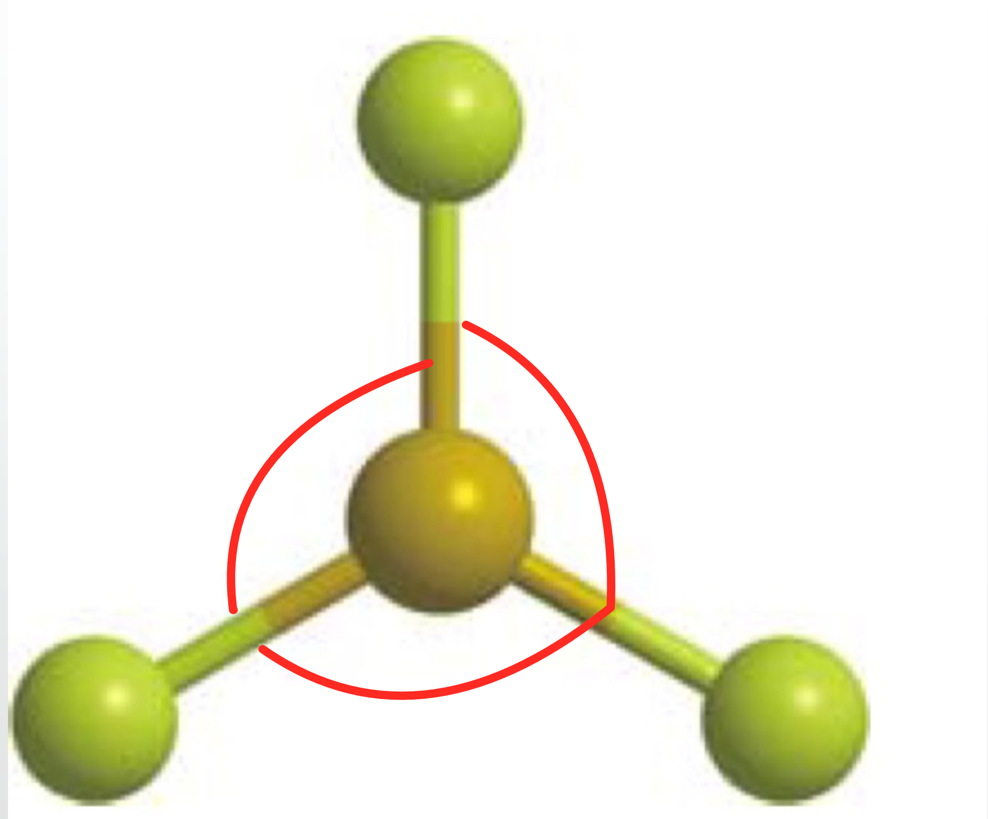


Example 2 : BF_3

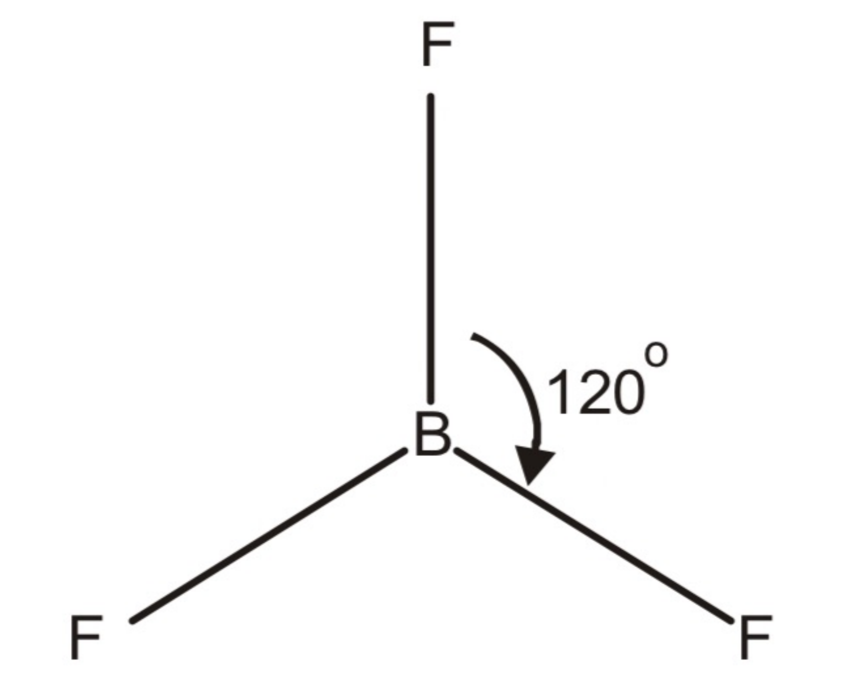
SN = 3+0=2

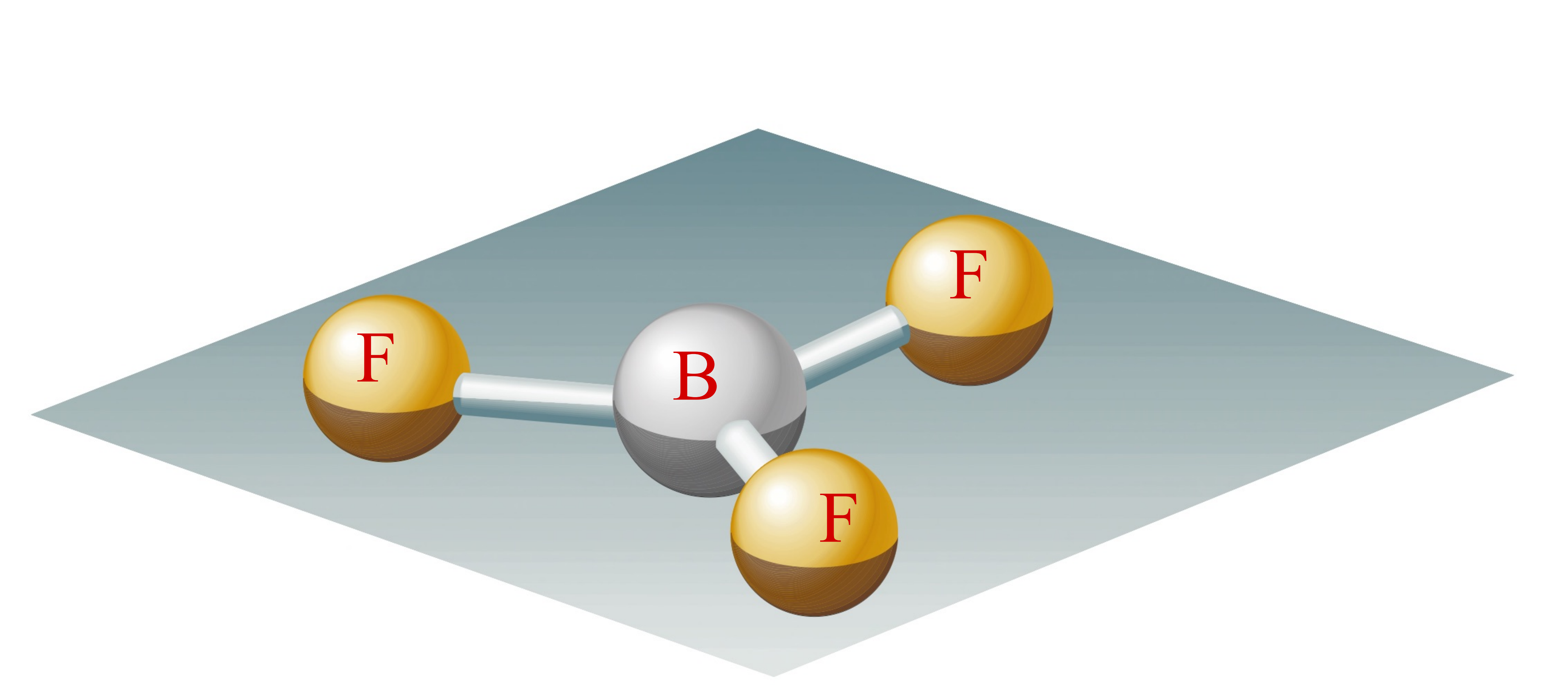
Hyb : Sp^2





Boron trifluoride





Trigonal planar
Planar molecule

(Q) Apply concept of Hybridisation in CH_4 molecule.

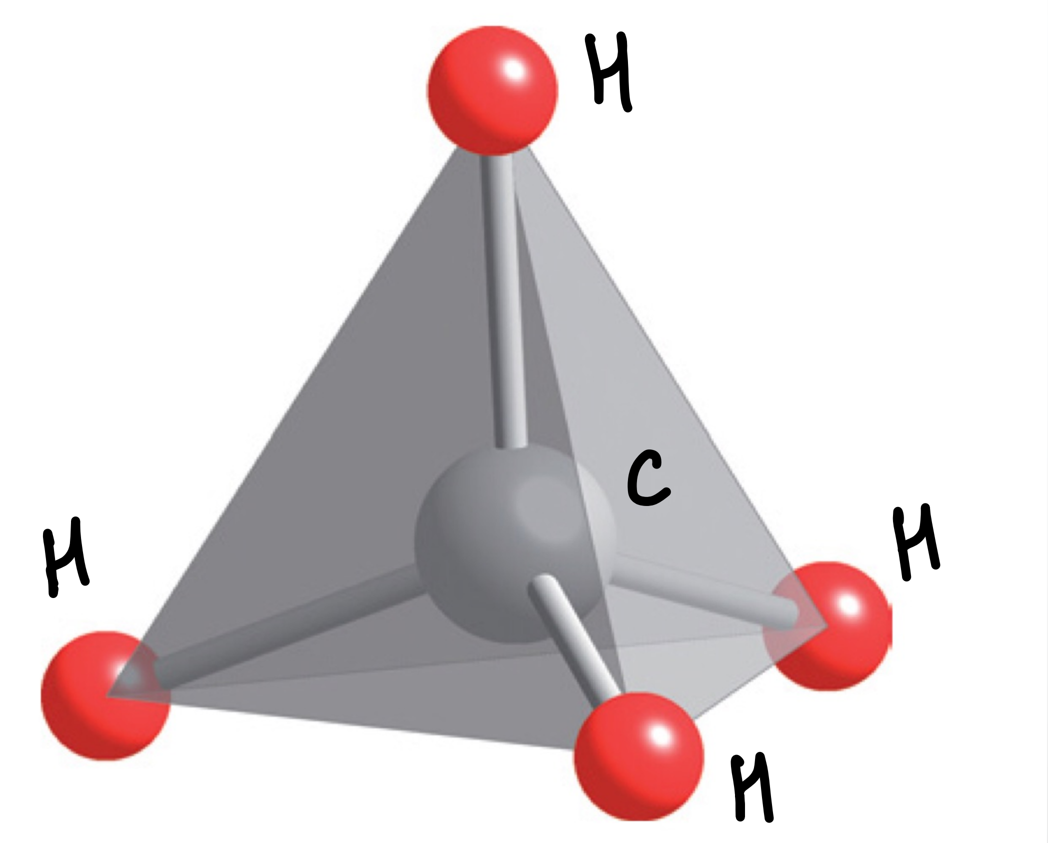
Ans:) $SN = \sigma\ Bond + lp$

$SN = 4 + 0$

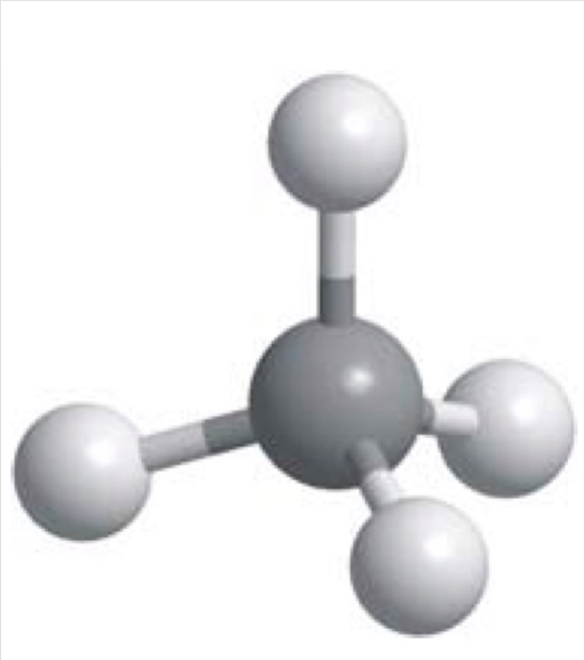
$= 4$

Hybridization : sp^3

$(s + p_x + p_y + p_z)$



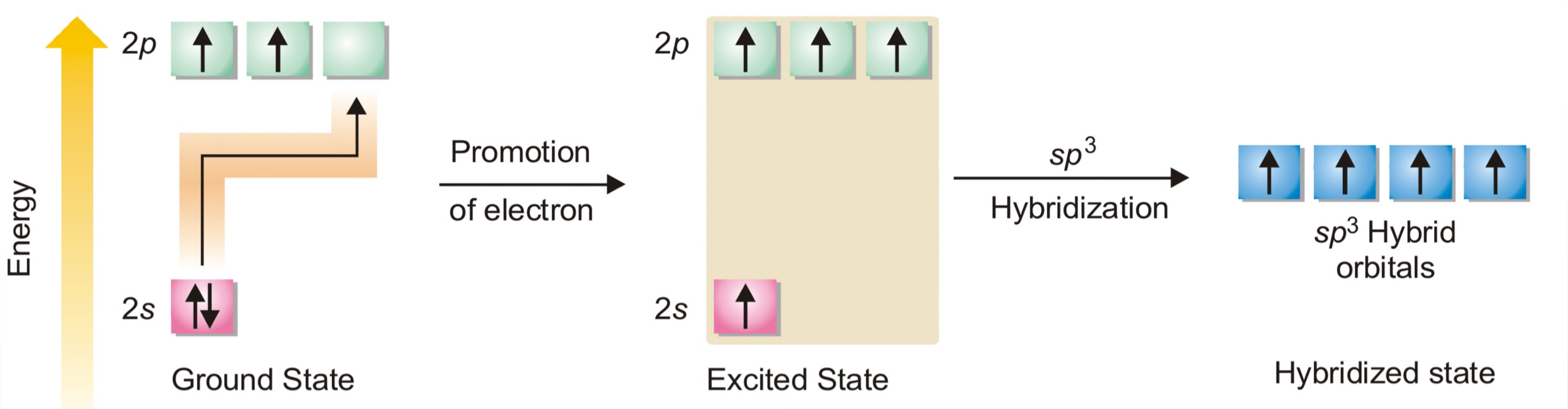
Shape : Tetrahedral



Methane

Non planar

Chemical Bonding



Example 3 : CH_4

SN = 4+0 = 4

Hyb : sp^3

(Q) find hybridisation of NH_4^+ .

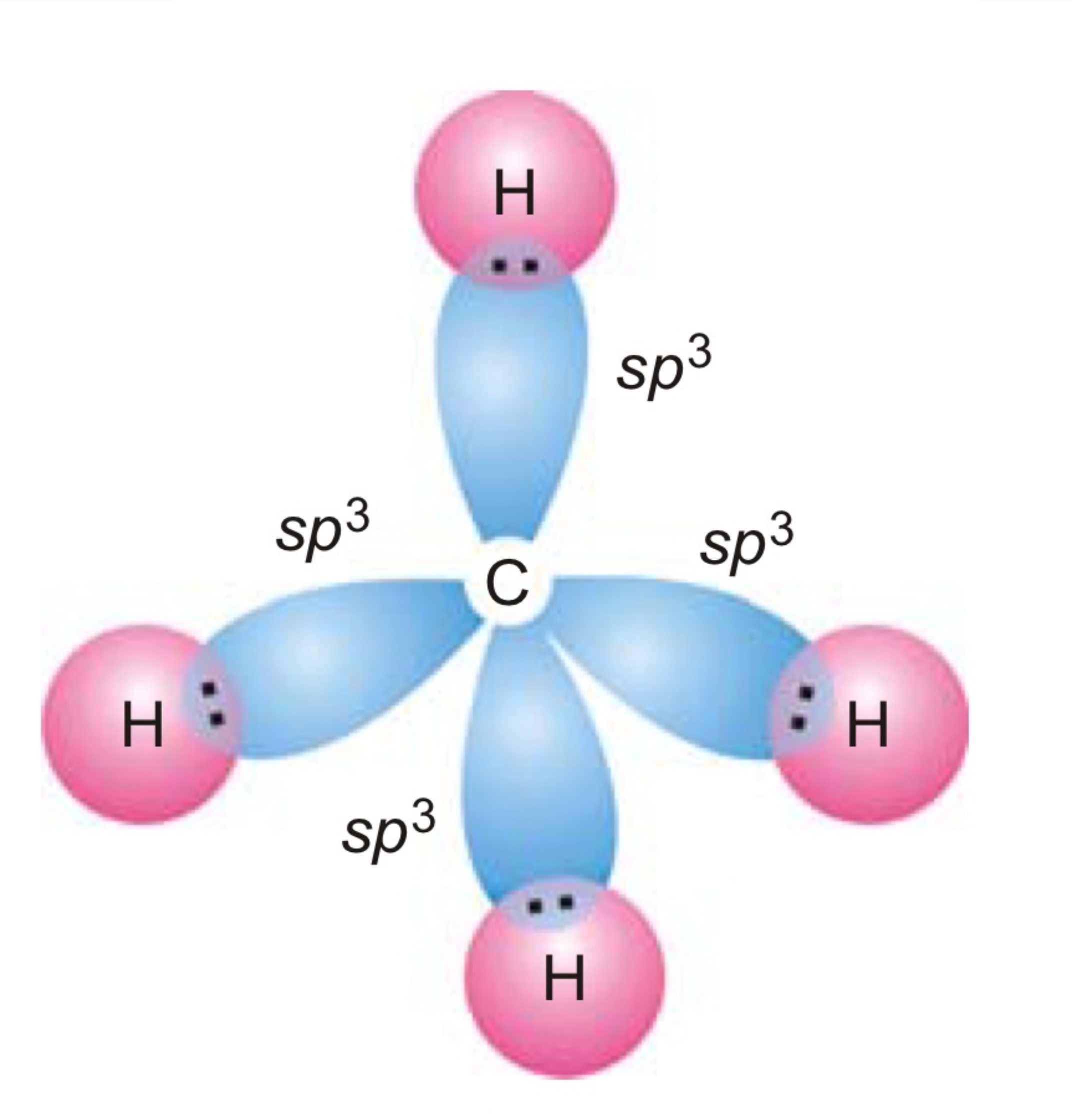
(Ans:) SN = no. of σ bond + lp

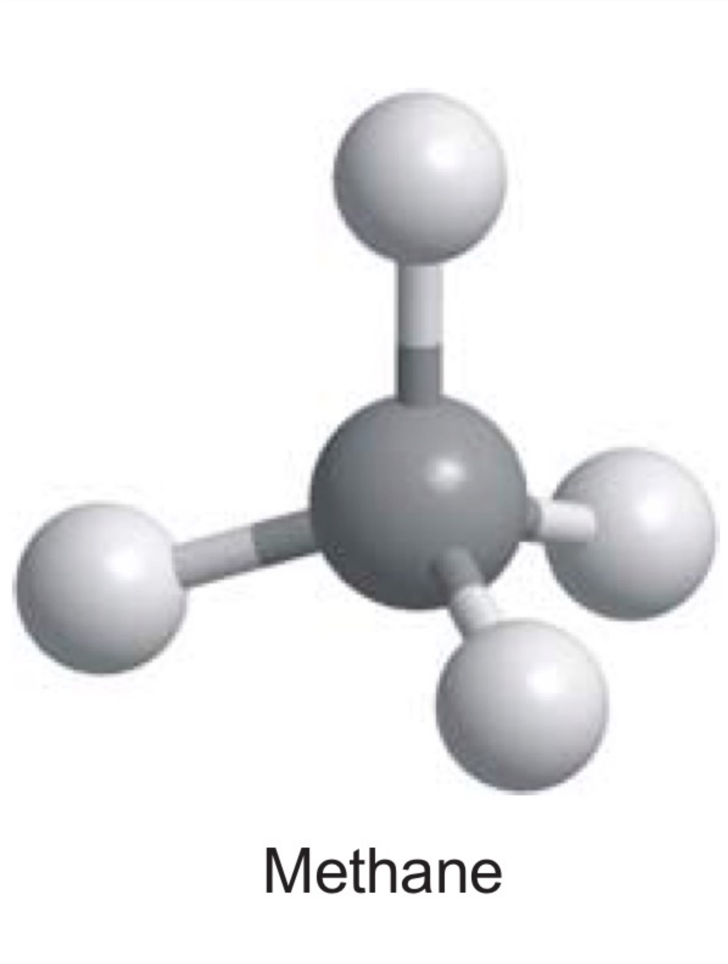
= 4 + 0

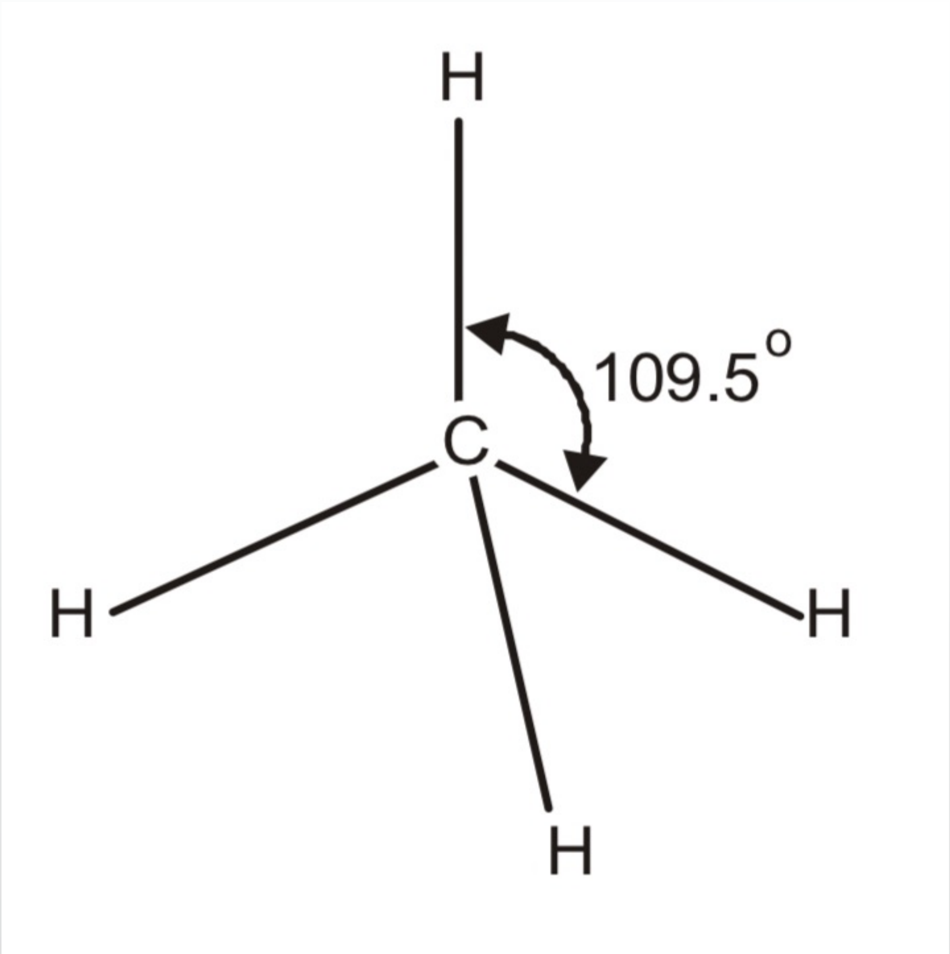
= 4

Hyb : sp^3

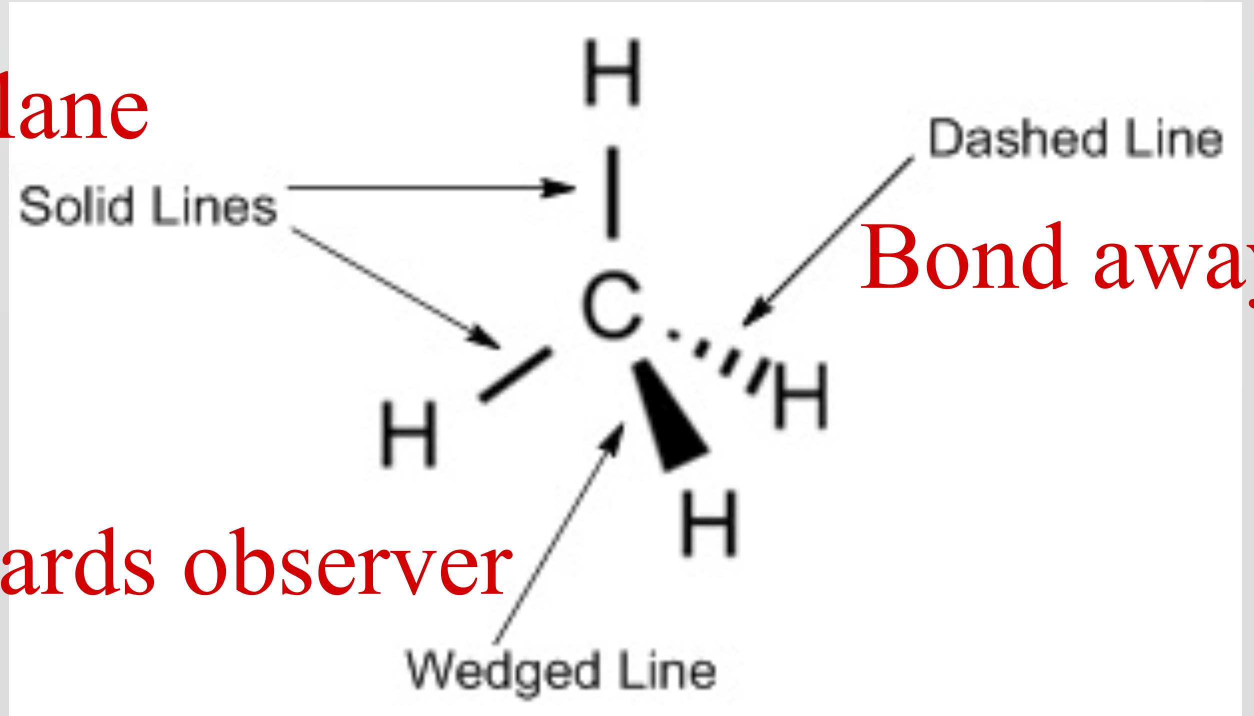
Shape | Geometry : Tetrahedral







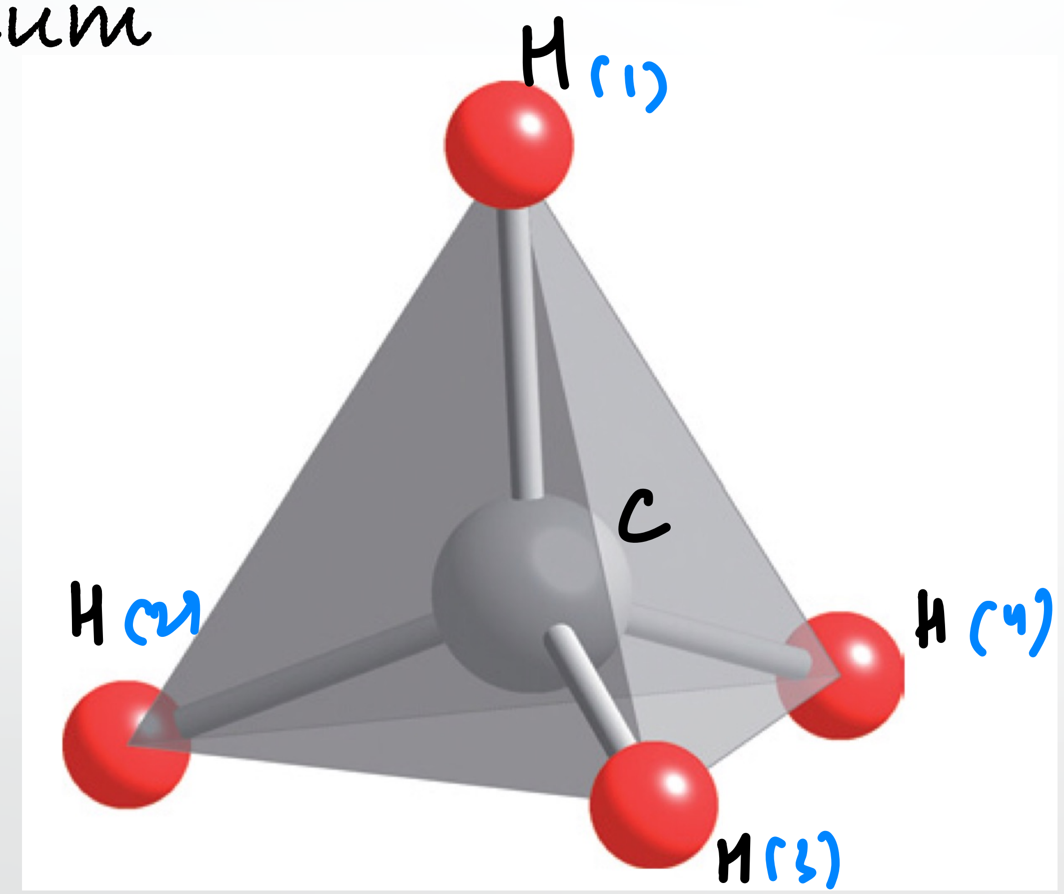
Bond in plane



Bond away from observer

Bond towards observer

(Q) find maximum number of planes containing maximum number of atoms in CH_4.



Ans: Number of planes.

$(H_1\ H_2\ H_3)$

$(H_1\ H_3\ H_4)$

$(H_2\ H_3\ H_4)$

$(H_1\ H_2\ H_4)$

4 plane

$(H_1\ C\ H_2)$

$(H_1\ C\ H_3)$

$(H_1\ C\ H_4)$

$(H_2\ C\ H_3)$

$(H_2\ C\ H_4)$

$(H_3\ C\ H_4)$

6 plane

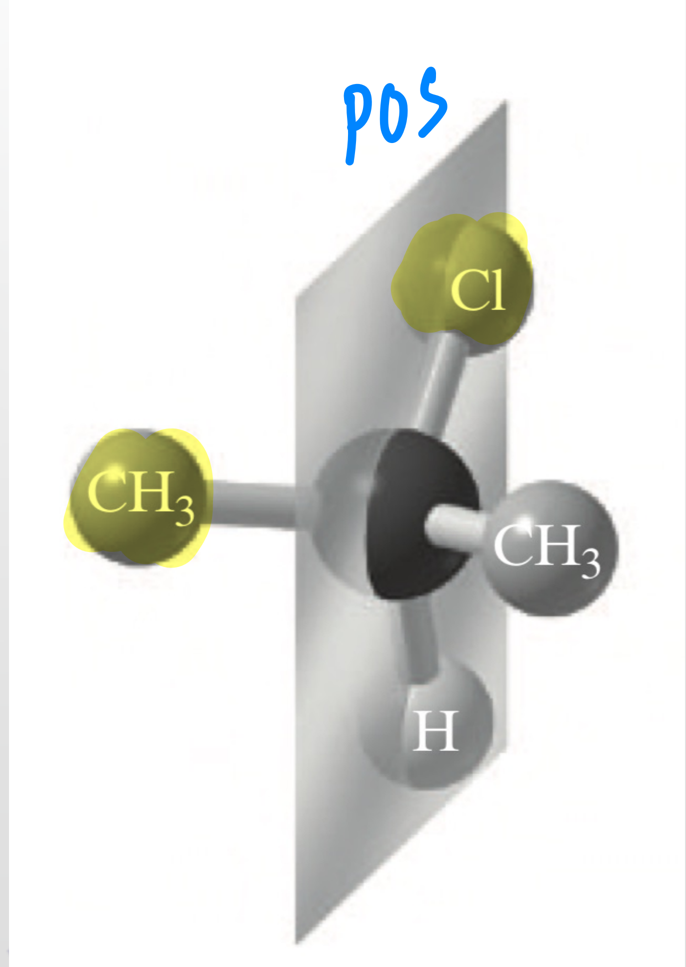
Maximum number of atom in one plane = 3

pos = 6.

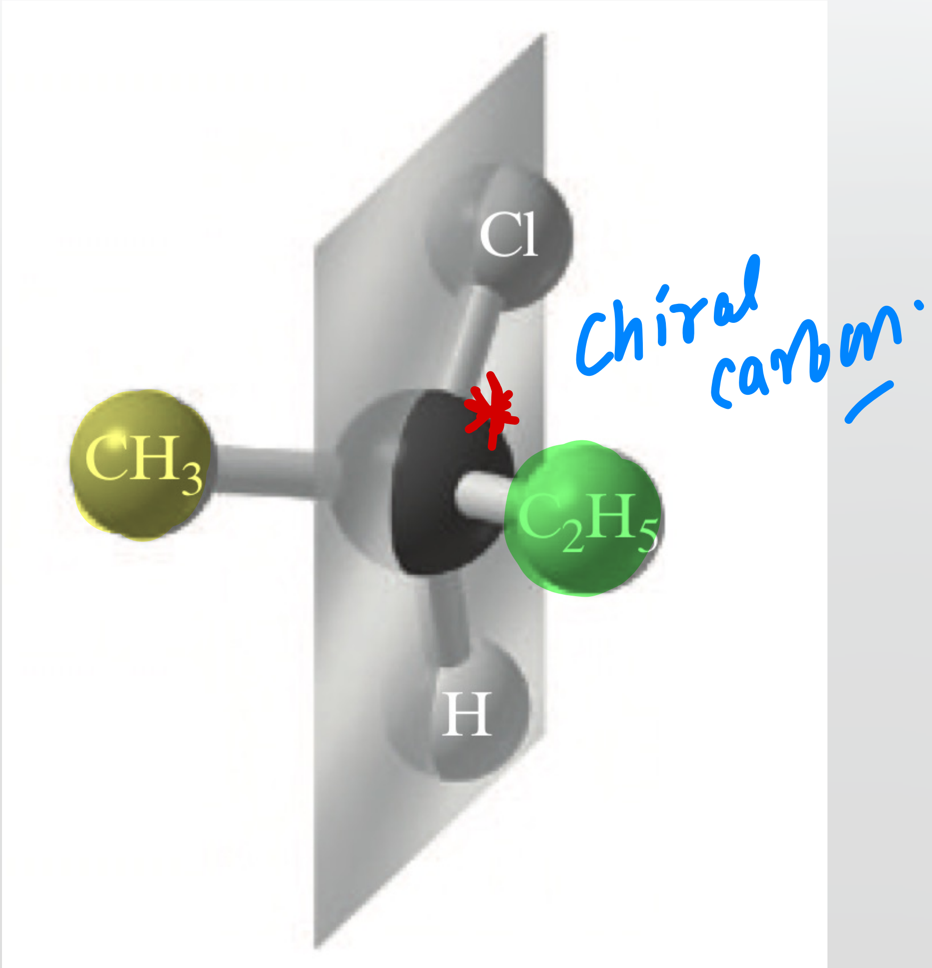
(Ans) 10 plane

Plane of symmetry

A **plane of symmetry** (also called a mirror plane) is defined as an imaginary plane that bisects a molecule in such a way that the two halves of the molecule are mirror images of each other. A molecule will not be chiral if it possesses a plane of symmetry.

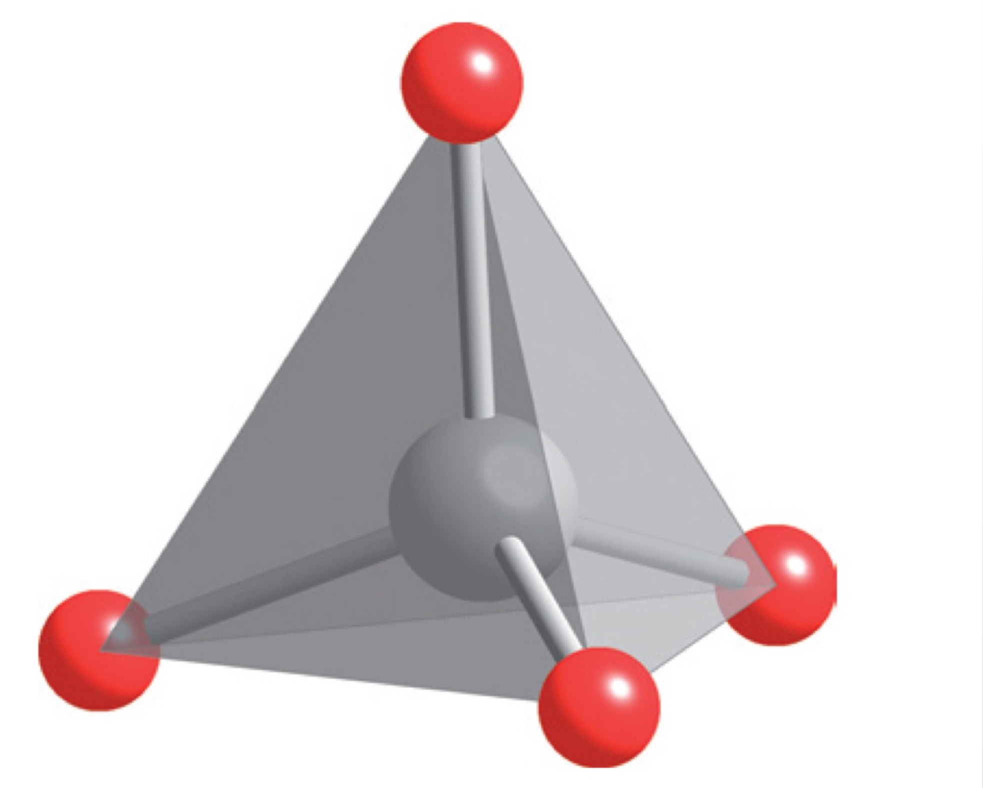


Plane of symmetry
Present



Plane of symmetry
Absent

(Q) How many planes of symmetry is present in CH_4 molecule?

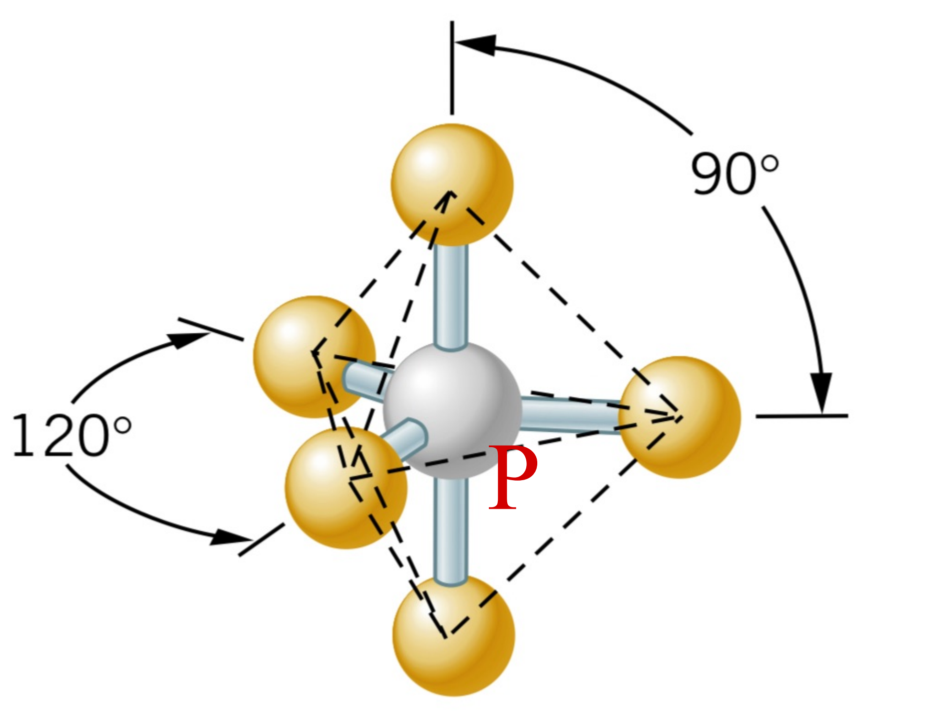


(Ans) 6

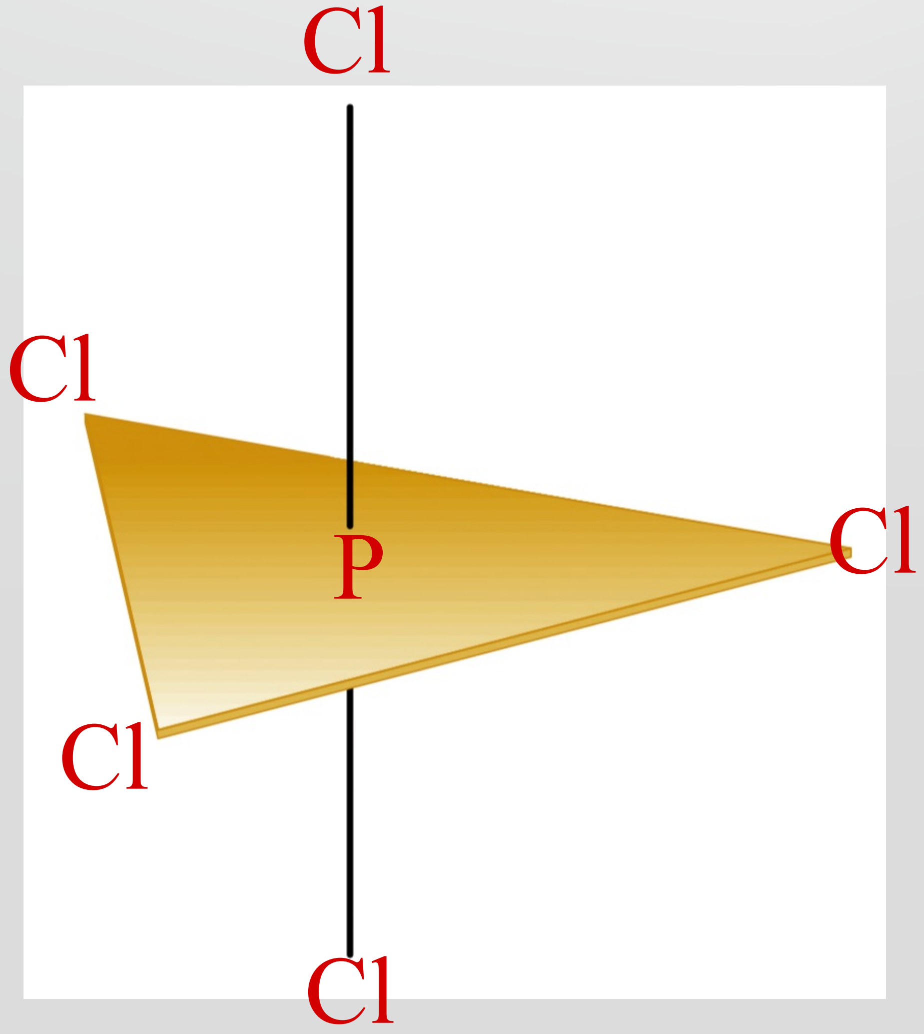
(Q) find hybridisation of P in PCl_5.

(Ans) : SN = No of σ Bond + lp
= 5 + 0
⇒ Hyb: sp^3d.

⇒ Shape | Geometry : Trigonal bipyramidal.

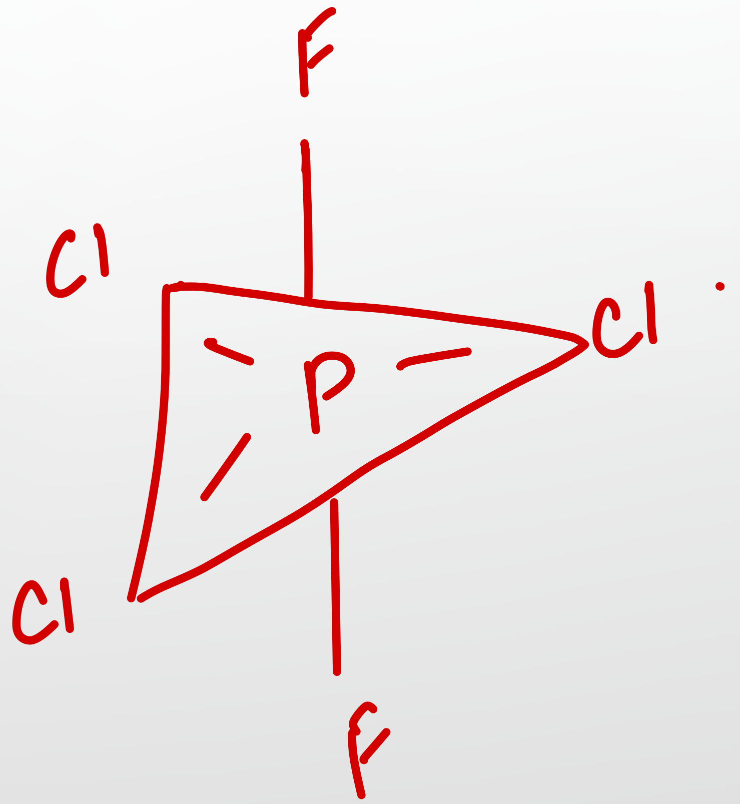


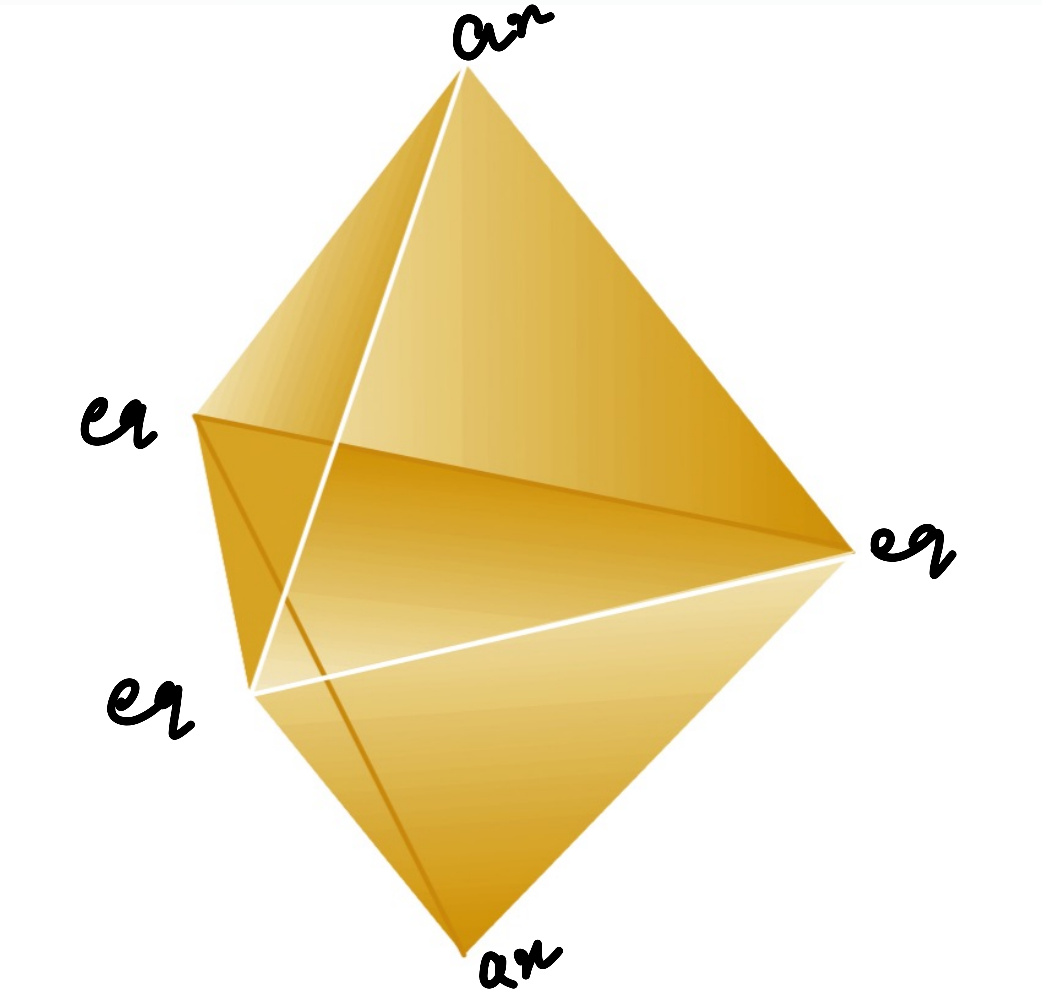
A trigonal bipyramidal molecule



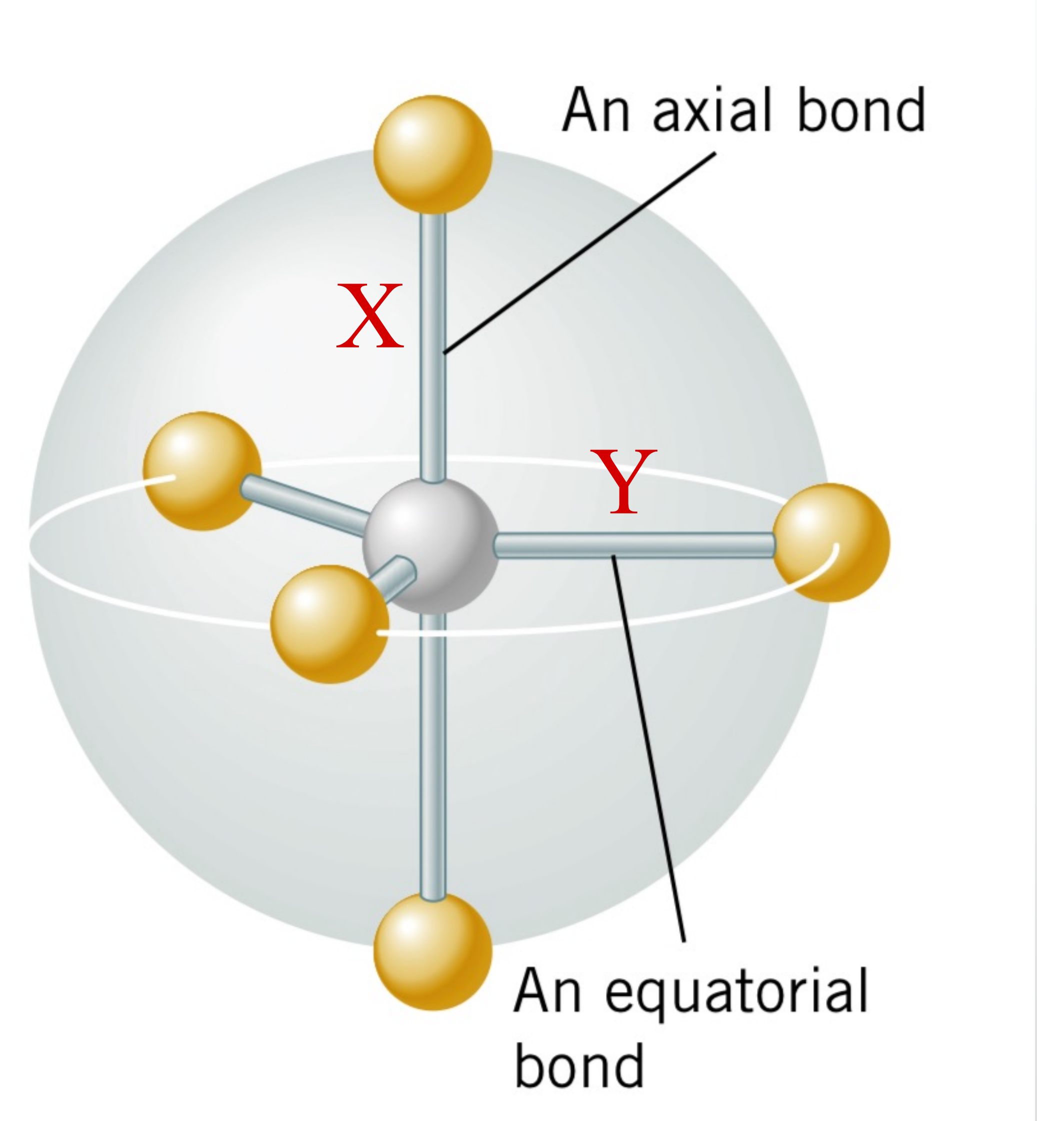
Some other example

PF_5 , PCl_3F_2 , XeO_3F_2





A trigonal bipyramid



* more electronegative atom occupy axial position.

EN: F > Cl
4.0 3.0

Bond length : X> Y
Axial bond length > equatorial bond length

BA ↑ BL ↓

(Q) find Hybridisation of s in SF_6

SN = No of σ Bond + lp

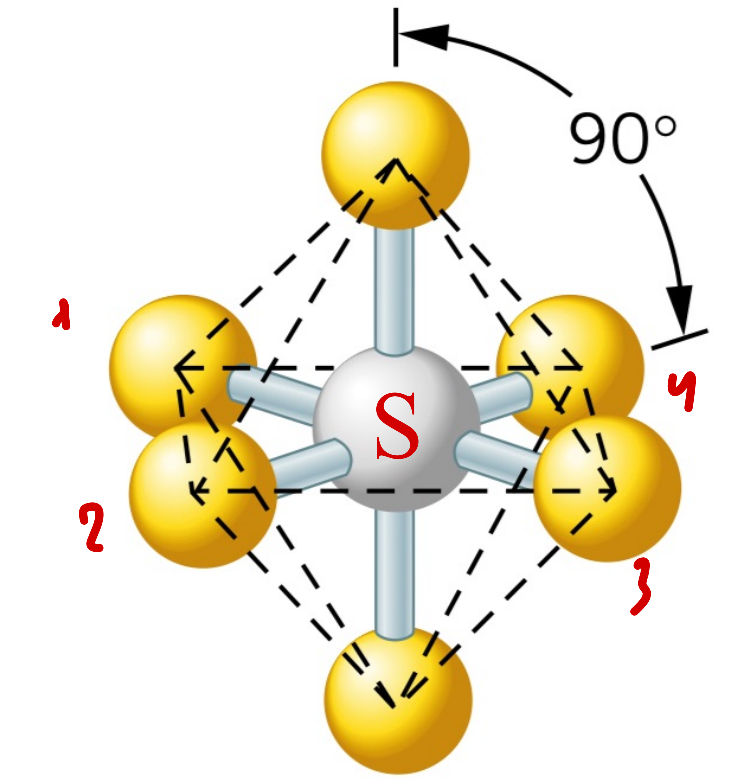
= 6 + 0

= 6

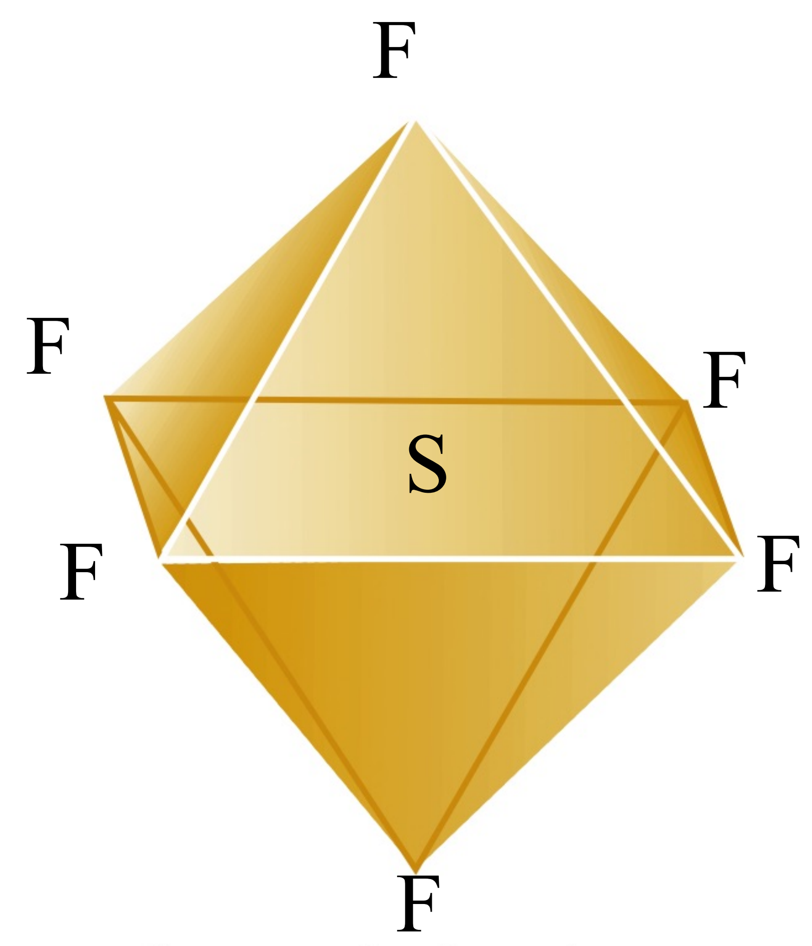
Hyb: sp^3d^2

Shape | Geometry : octahedral.

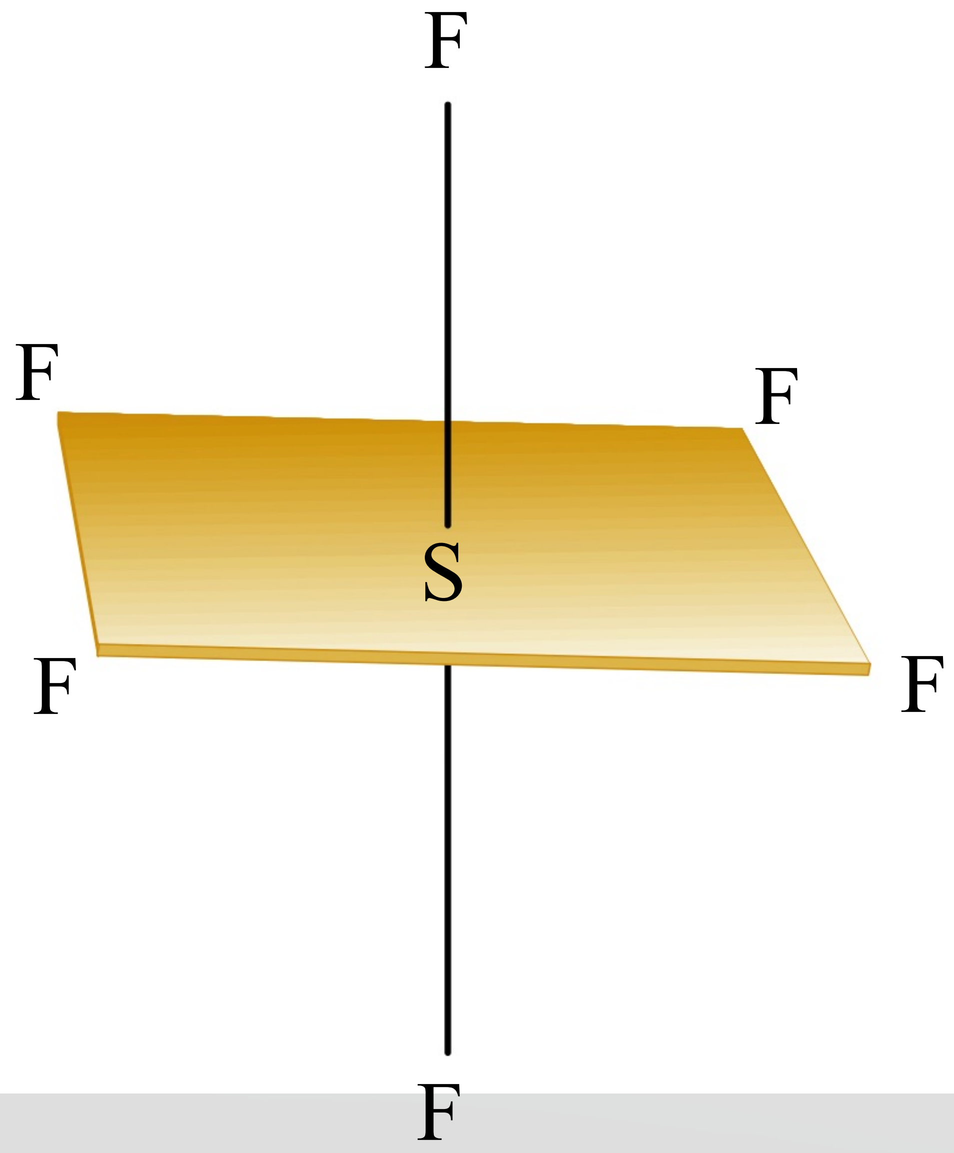
| Square bi pyramidal.



An octahedral molecule



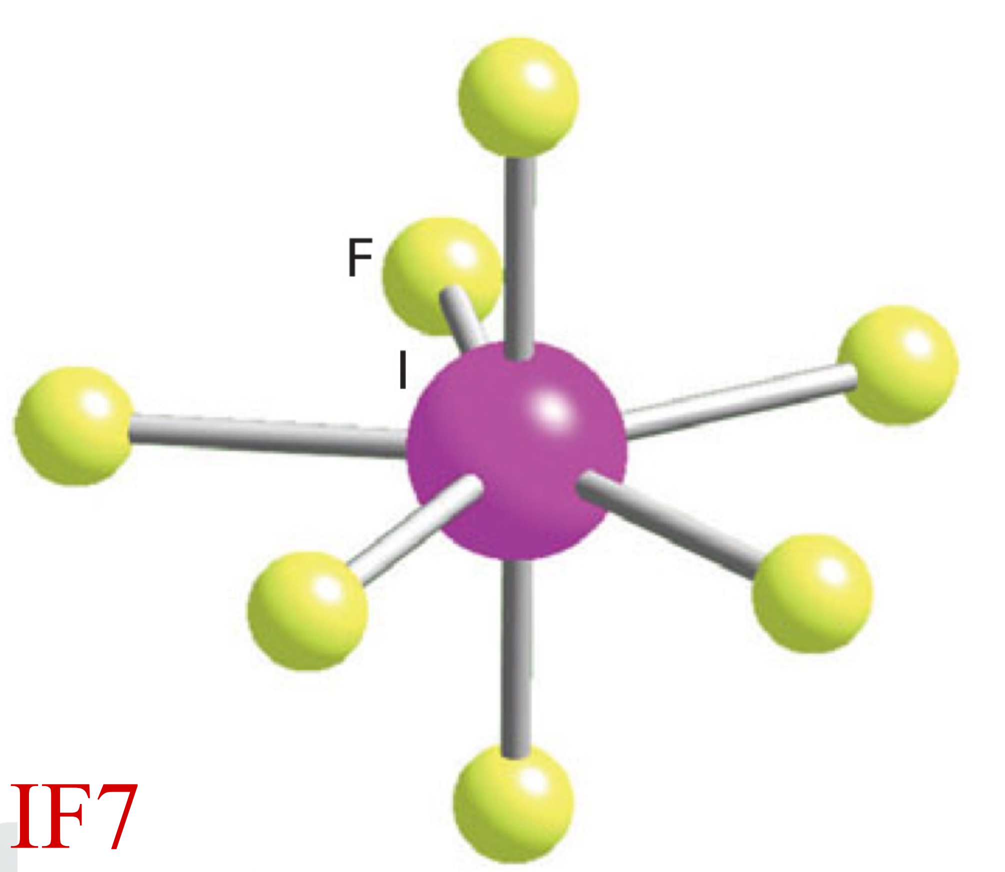
An octahedron



(Q) find hybridisation of I in IF7

(Ans:) SN : 7

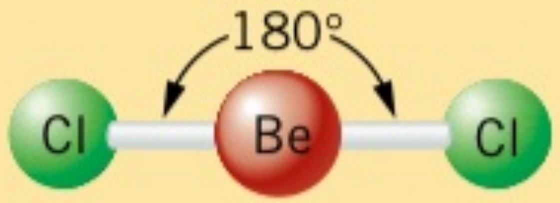
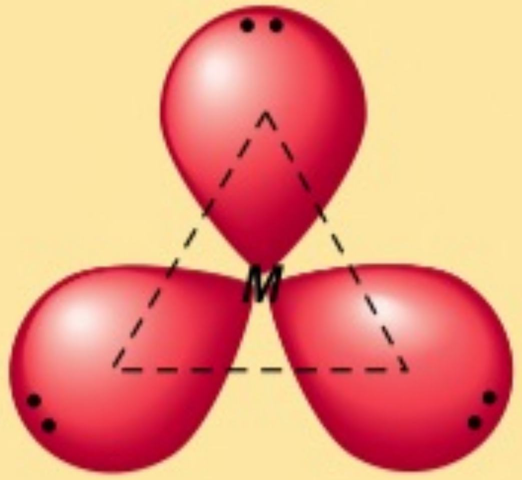
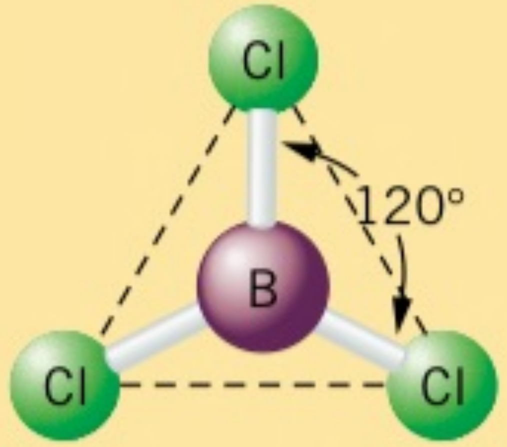
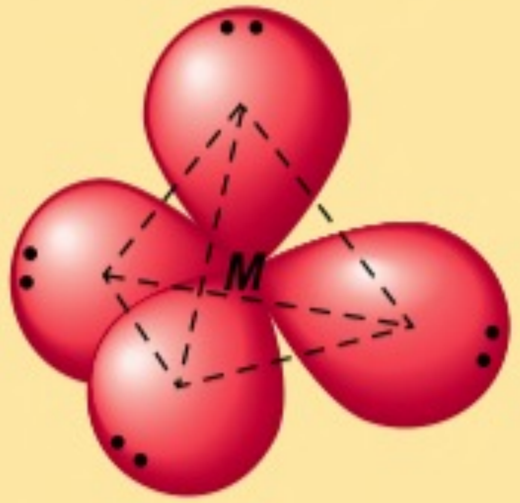
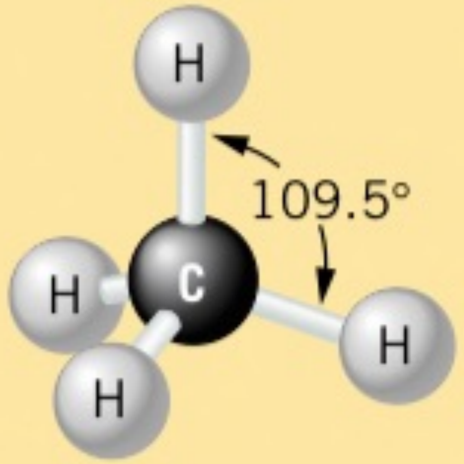
Hyb: sp^3d^3.

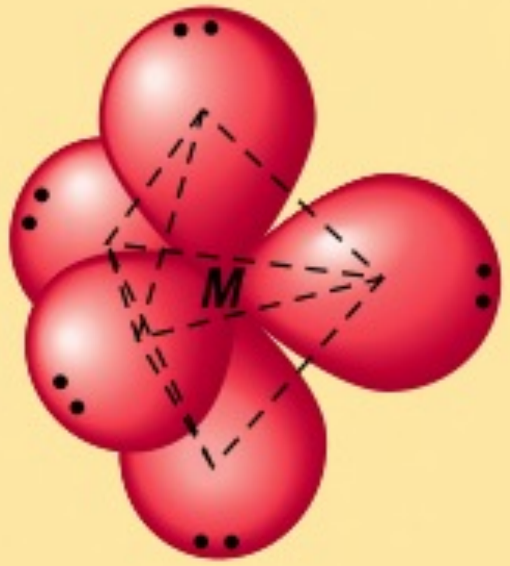
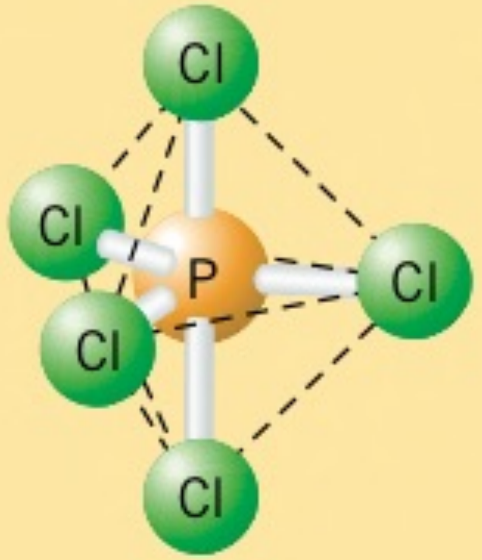
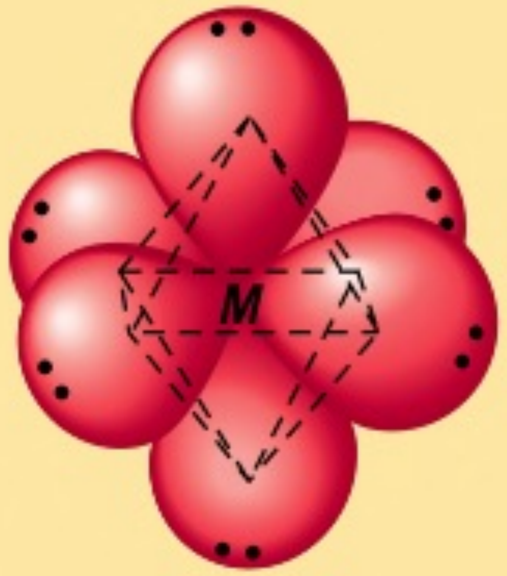
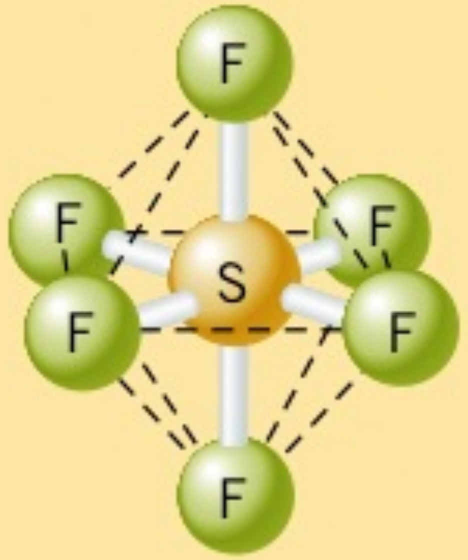


IF7

Pentagonal Bipyramidal

Five basic molecular geometry

2		Linear	$BeCl_2$	
3		Planar triangular	BCl_3	
4		Tetrahedral (A tetrahedron is pyramid shaped. It has four triangular faces and four corners.)	CH_4	

5		Trigonal bipyramidal (This figure consists of two three-sided pyramids joined by sharing a common face—the triangular plane through the center.)	PCl_5	
6		Octahedral (An octahedron is an eight-sided figure with *six* corners. It consists of two square pyramids that share a common square base.)	SF_6	

Note : There is no lone pair on central atom in all the above cases.

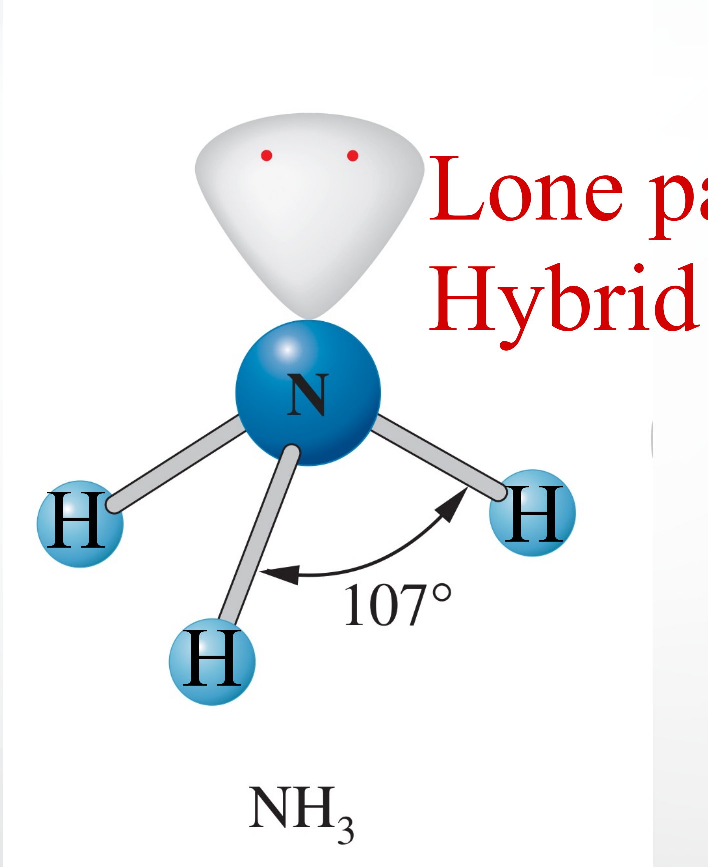
Chemical Bonding

VSEPR (Valence shell electron pair repulsion theory)

Order of repulsion

Lp-Lp > Lp - Bp > Bp- Bp

Lp : lone pair
Bp : Bond pair



Lone pair in Sp3
Hybrid orbital

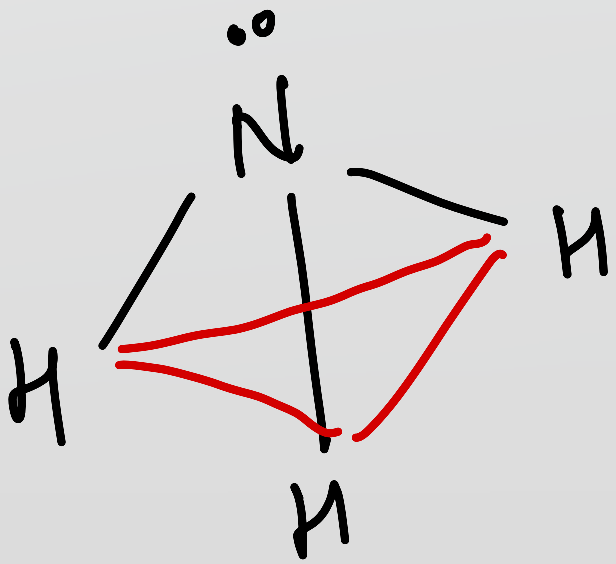
(Q) Apply concept of hybridisation in $\ddot{N}H_3$ molecule.

(Ans:) SN = No. of σ Bond + no of lp

= 3 + 1

= 4

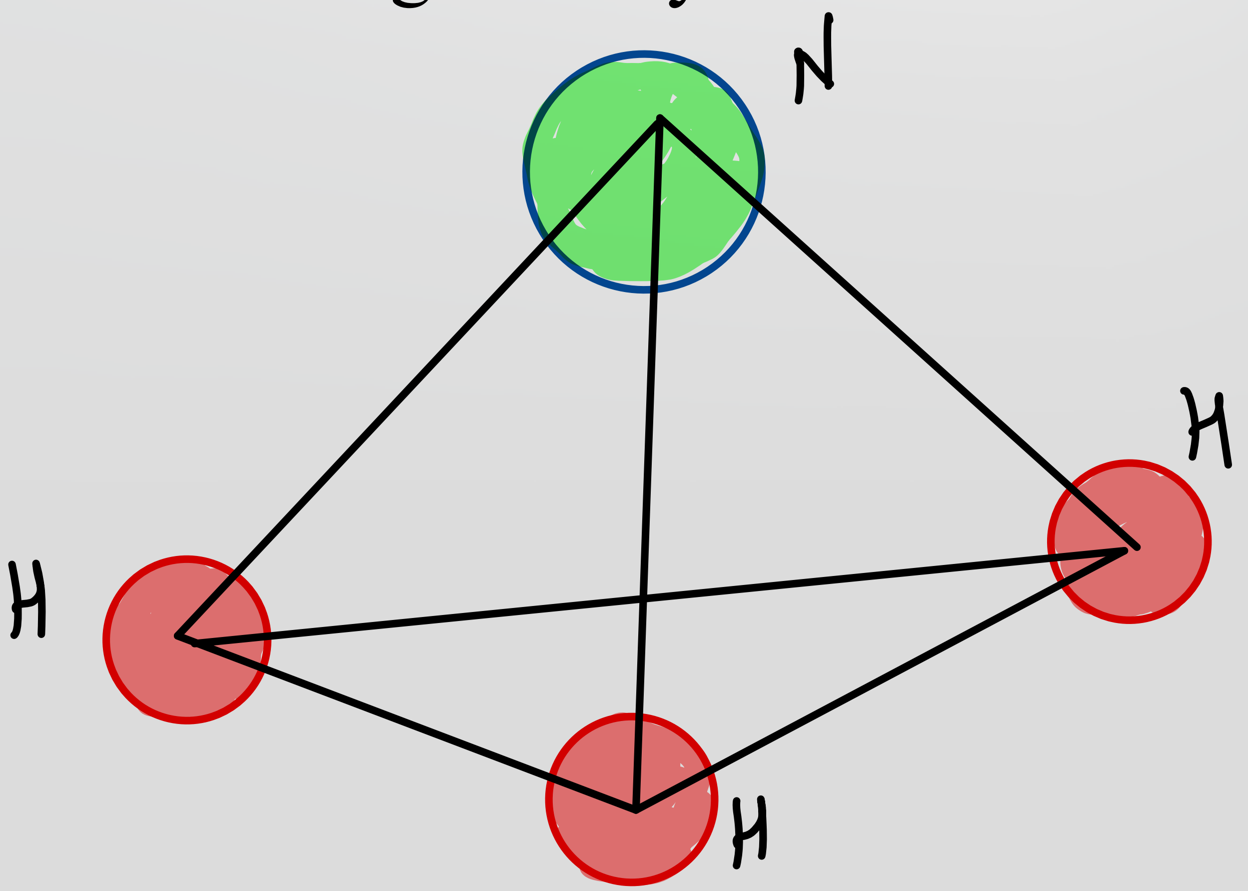
Hyb: Sp^3.

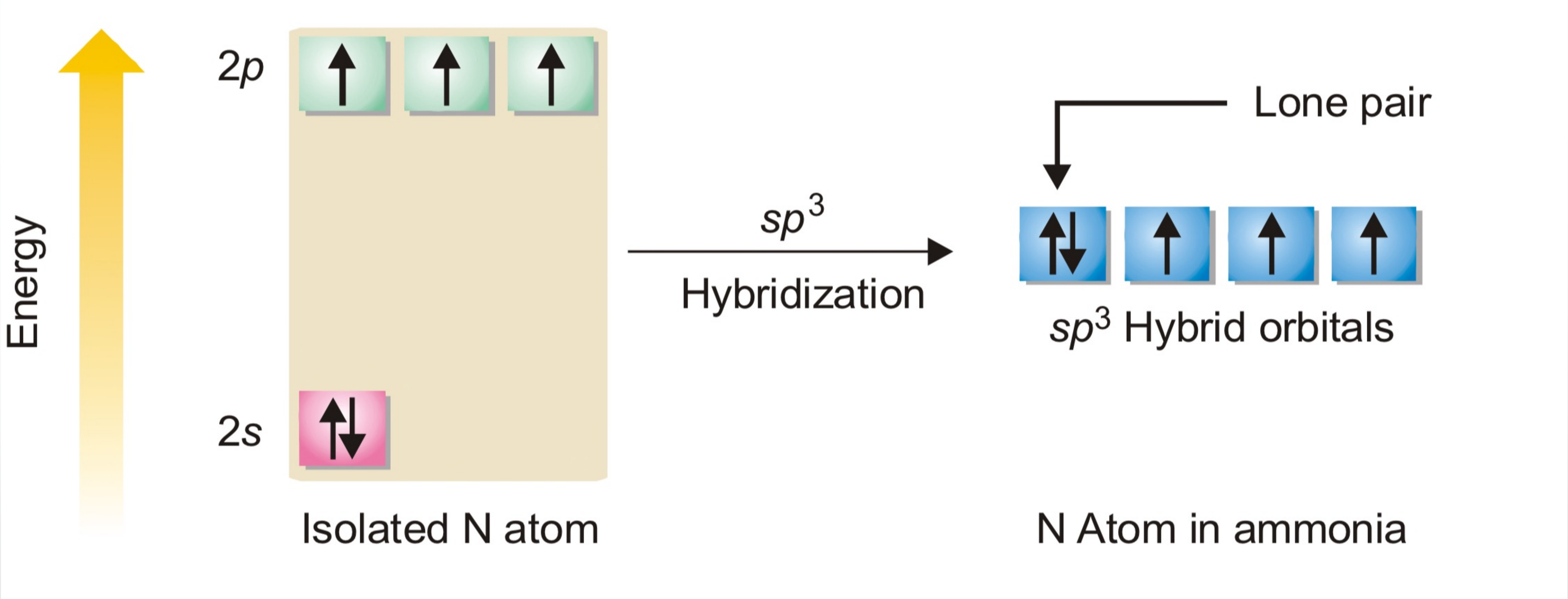


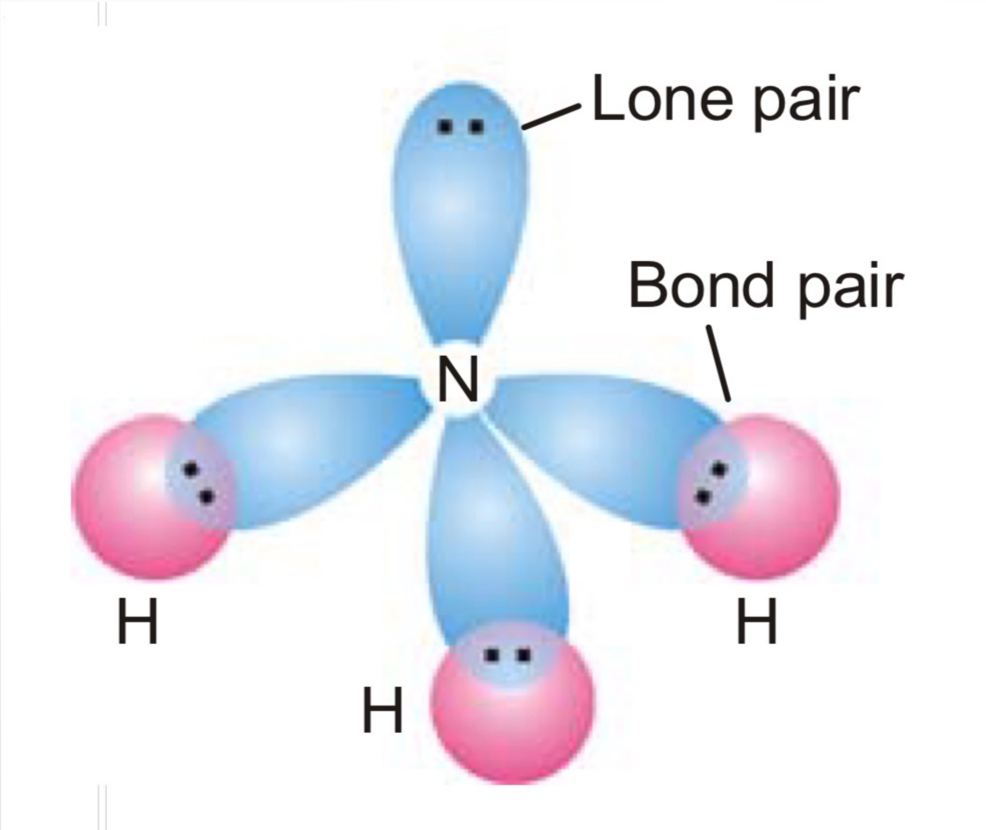
Geometry/Shape : trigonal pyramidal

Non planar molecule

Electronic geometry: tetrahedral







Example 4: NH_3

$SN = 3+1 = 4$

Hyb : sp^3

Calculation of hybridisation

Total hybrid orbital (T.H.O) / steric No. (S.N) = number of sigma bond + lone pair

THO/SN	Hybridisation
2	Sp
3	Sp^2
4	Sp^3
5	$Sp^3 d$
6	$Sp^3 d^2$
7	$Sp^3 d^3$

Note: π Bond not counted in calculating THO

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Hybridisation (Atomic orbital used)

1. $sp\ (s+p_x)$

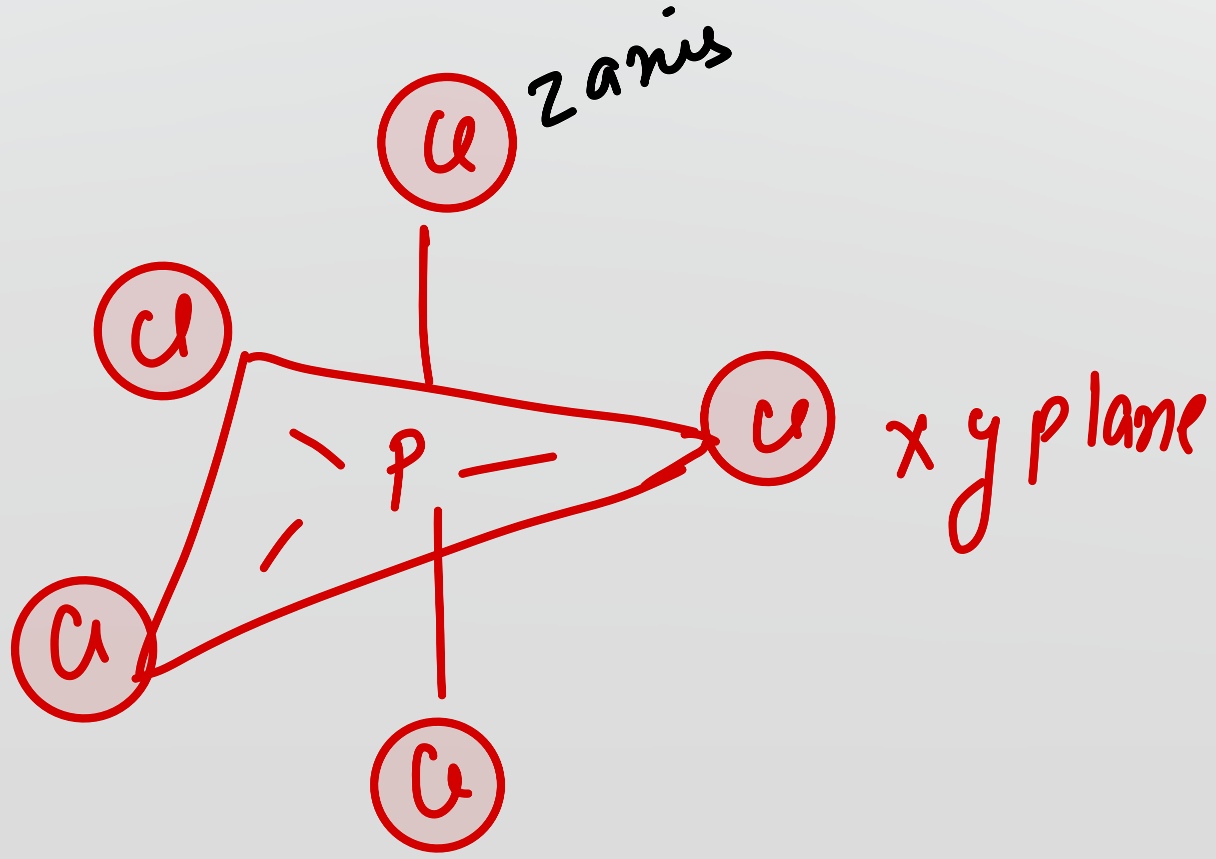
2. $sp^2(s+p_x+p_y)$

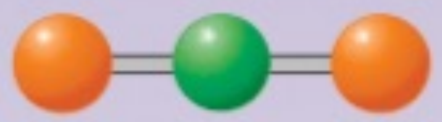
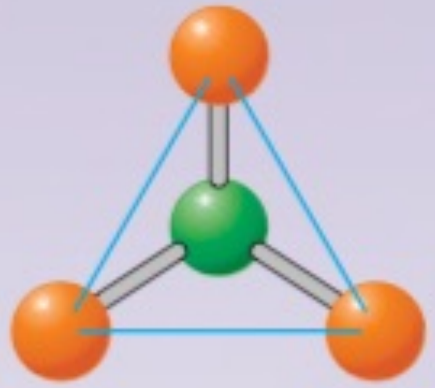
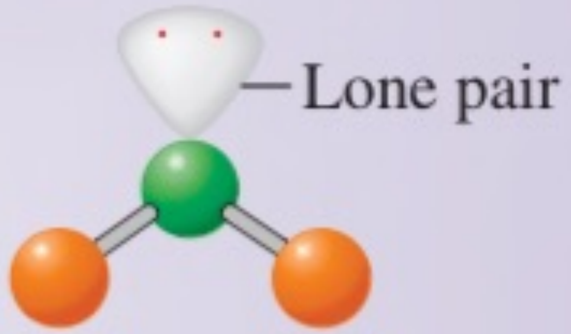
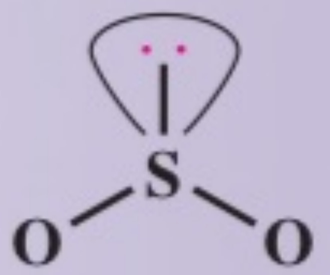
3. $sp^3(s+p_x+p_y+p_z)$

4. $sp^3d(s+p_x+p_y+p_z+d_{z^2})$ *

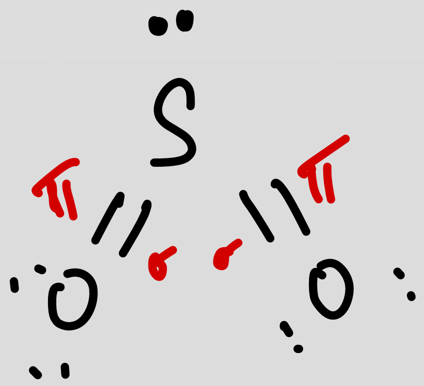
5. $sp^3d^2(s+p_x+p_y+p_z+d_{z^2}+d_{x^2-y^2})$

6. $sp^3d^3\ (s+p_x+p_y+p_z+d_{z^2}+d_{x^2-y^2}+d_{xy})$



Electron Pairs Total	Bonding	Lone	Arrangement of Pairs		Molecular Geometry	Hybridisation	Example	
SN.	Bp.	Lp						
2	2	0	Linear	Linear AX_2		Sp	BeF_2	F—Be—F
3	3	0	Trigonal planar	Trigonal planar AX_3		Sp2	BF_3	
	2	1		Bent (or angular) AX_2			SO_2	

example



$SN = \overset{\sigma}{2} + \overset{lp}{1}$

$= 3$

Hyb : sp^2

Calculating steric number for molecule

1. BeF_2

2. BF_3

3. SO_3

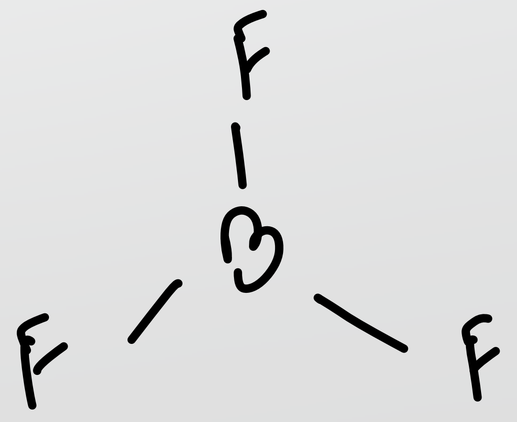
(1.) BeF_2 F — Be — F

SN = 2

Hyb : sp

Shape: linear.

(2)

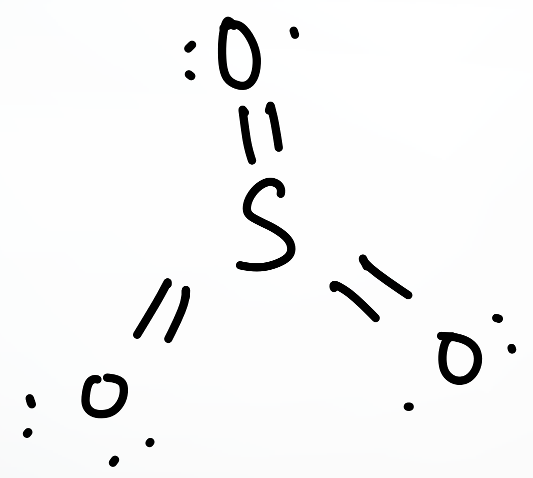


SN : 3

Hyb : sp^2

Shape : Trigonal planar.

(3)



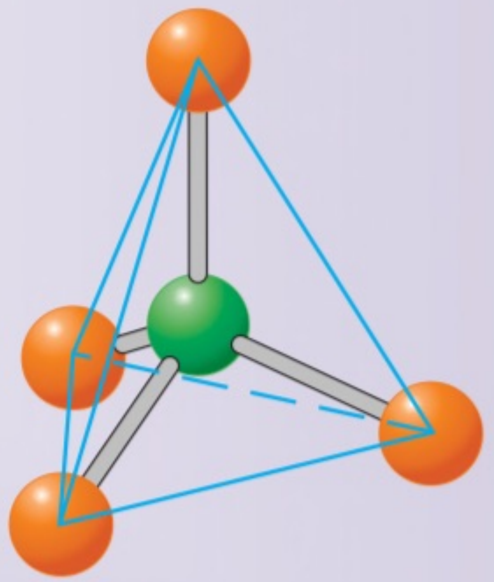
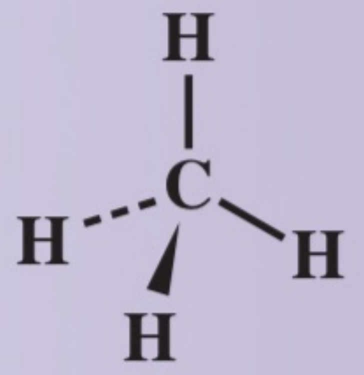
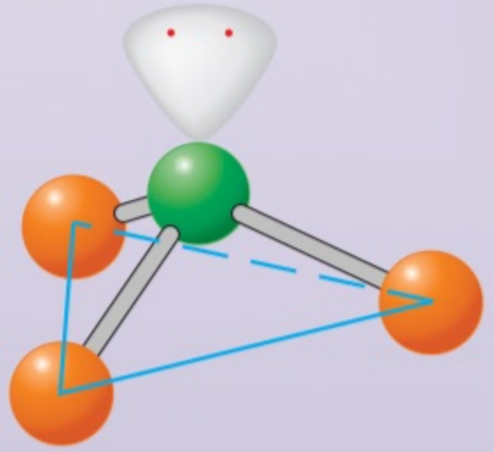
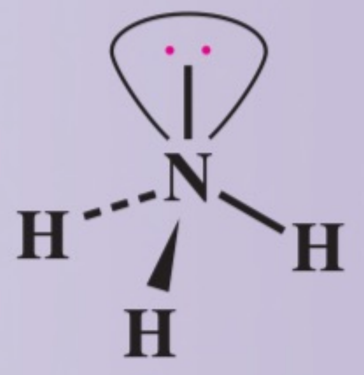
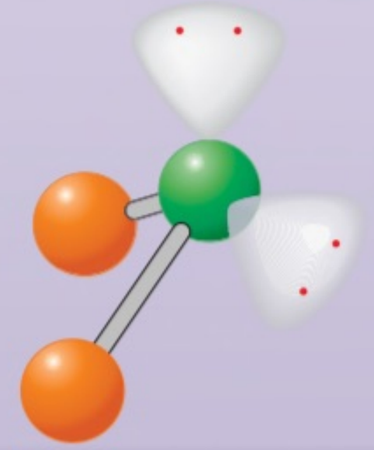
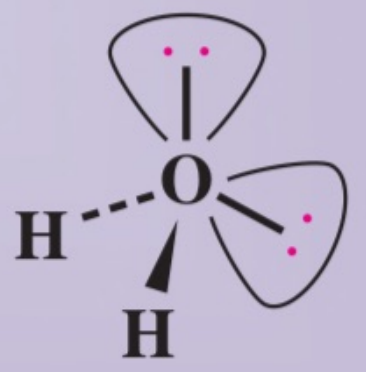
SN = σ Bond + lp

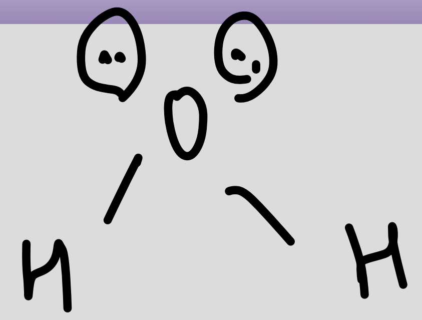
= 3 + 0

= 3

Hyb : sp^2

Shape: Trigonal planar.

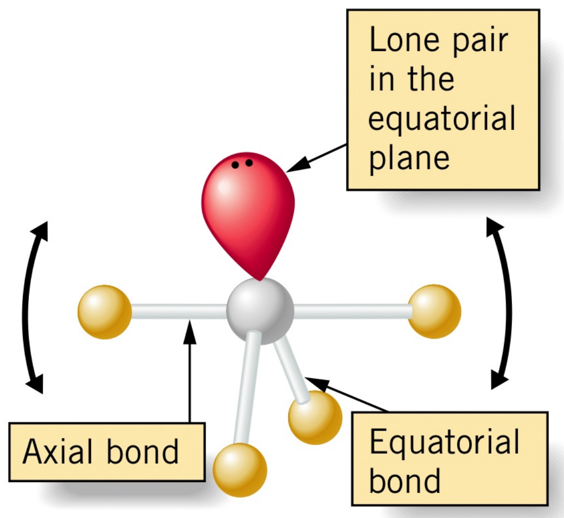
SN.	Bp.	Lp	Arrangements of pair	Molecular shape		Sp3	
4	4	0	Tetrahedral	Tetrahedral AX_4		CH_4	
	3	1		Trigonal pyramidal AX_3		NH_3	
	2	2		V / Bent (or angular) AX_2		H_2O	

example 

$SN = \sigma + lp$
$= 2 + 2 = 4$

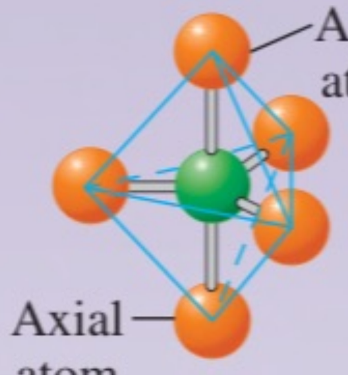
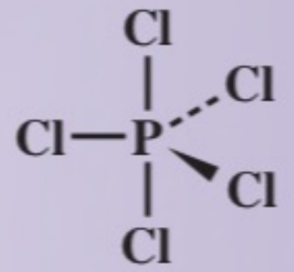
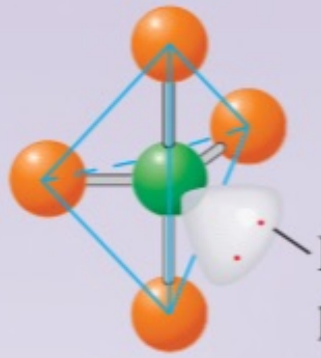
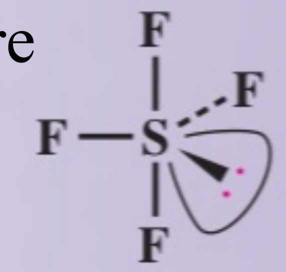
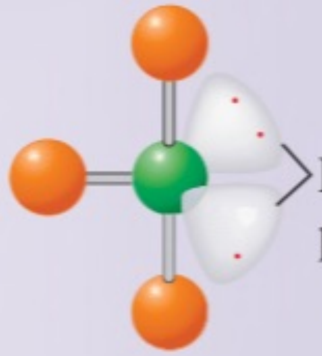
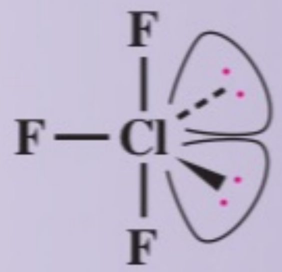
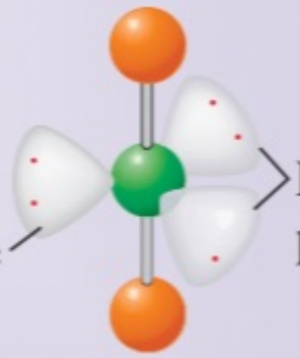
Hyb : Sp^3

Chemical Bonding



Example :SF4

Sp3d

Electron Pairs Total	Bonding	Lone	Arrangement of Pairs	Molecular Geometry	Example
5	5	0	Trigonal bipyramidal	Trigonal bipyramidal AX_5 	PCl_5 
	4	1		Seesaw (or distorted tetrahedron) AX_4 	Folded square SF_4 
	3	2		T-shaped AX_3 	ClF_3 
	2	3		Linear AX_2 	XeF_2