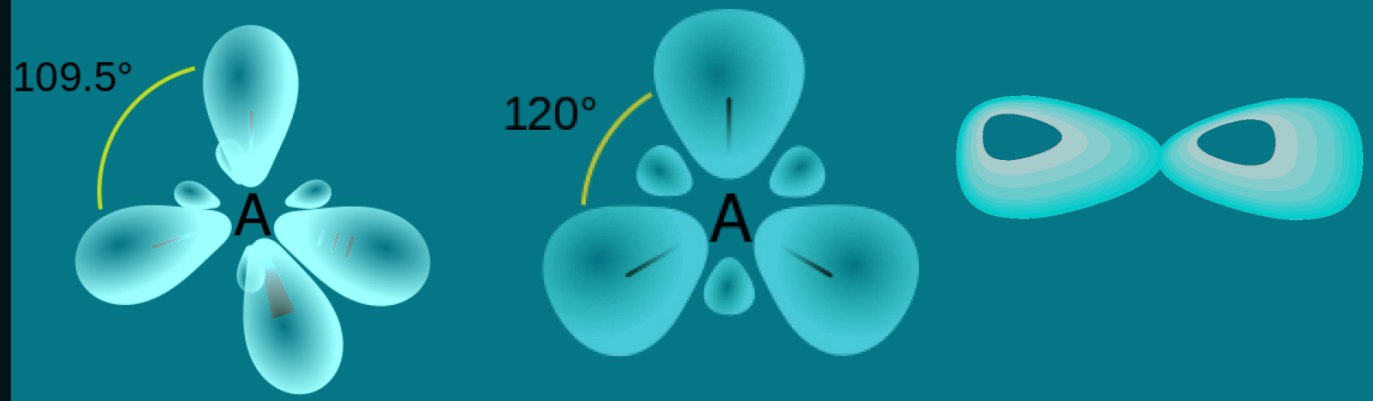
Hybridization

Basic Concepts



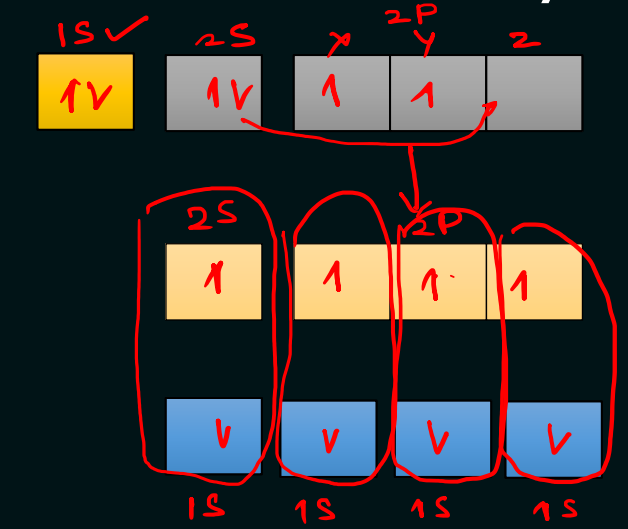
B.Pharm. | POC-I | U 2 | L2

Hybridization

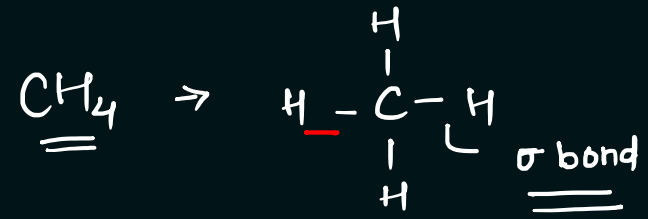
- hybridization is the process of combining of same or nearly same energy atomic orbitals to create new hybrid orbitals (having the exact same energy level) that can pair electrons to form chemical bonds

C6 → $1S^2$ $2S^2$ $2P^2$

H1 → $1S^1$



1st Excitation



- As per VBT, C-H bond may be differ due to made by different orbital **BUT**
- All C-H bonds are equivalent in all respects: same bond length, bond energy.

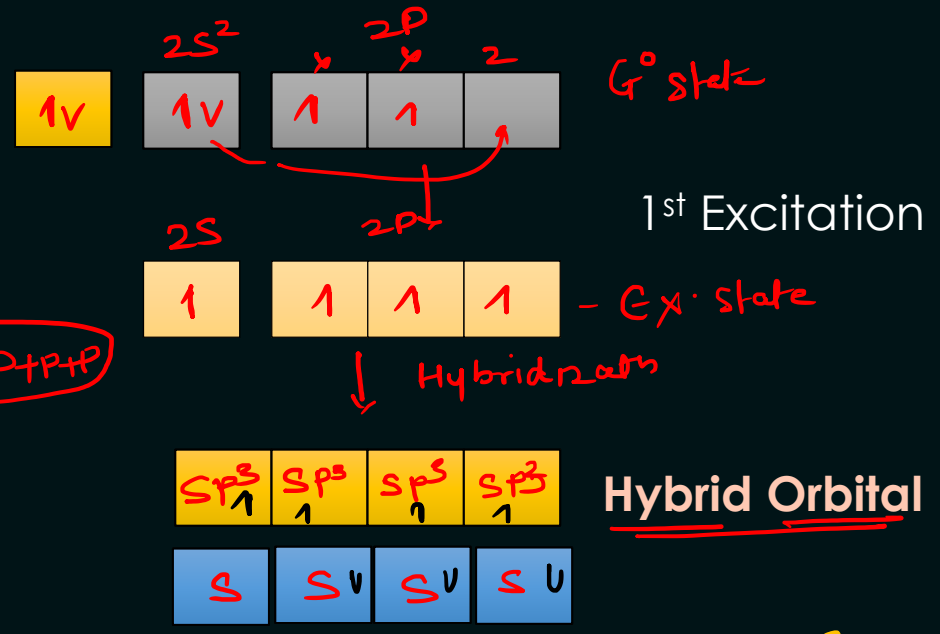
Hybridization

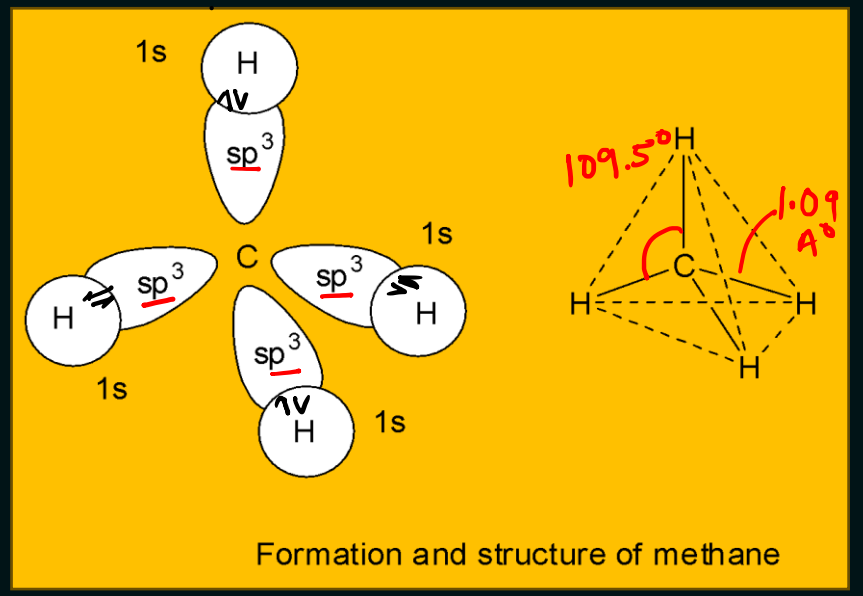
Hybridization

CH_4

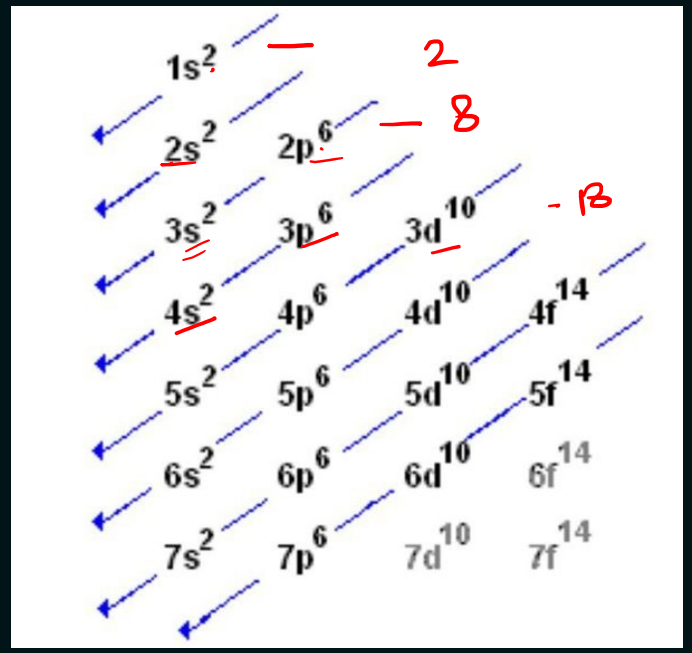
C6 → $1S^2$ $2S^2$ $2P^2$

H1 → $1S^1$



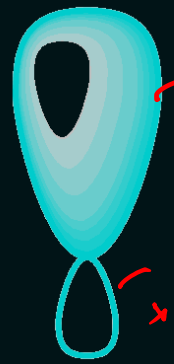


Sp³



S

P



Hybrid Orbital

Hybridization

- hybridization is the process of combining of same or nearly same energy atomic orbitals to create new hybrid orbitals (having the exact same energy level) that can pair electrons to form chemical bonds
- It occurs in-
  - Half Orbital
  - Empty Orbital — co-ordinate bond
  - Fully filled orbital — lone pair
- The No. Of Hybrid orbital = No of intermixing Orbital
- Sigma bond and lone pair electrons are involved in Hybridization
- The formed hybrid orbitals oriented with minimized repulsion between them to maximize the structure stability and make a stable Geometry.

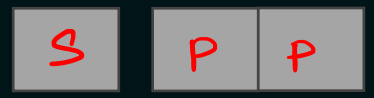
π → not any role

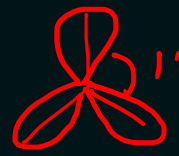
Hybridization

Hybridization Types

- sp - 

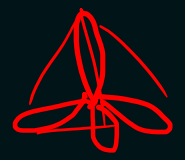
Linear Geometry

- sp^2 



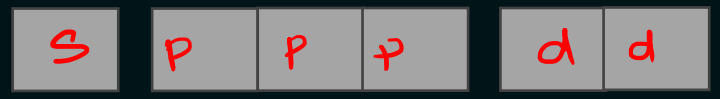
Trigonal planer

- sp^3 


Tetrahydral

- sp^3d 

Trigonal Bipyramidal

- sp^3d^2 

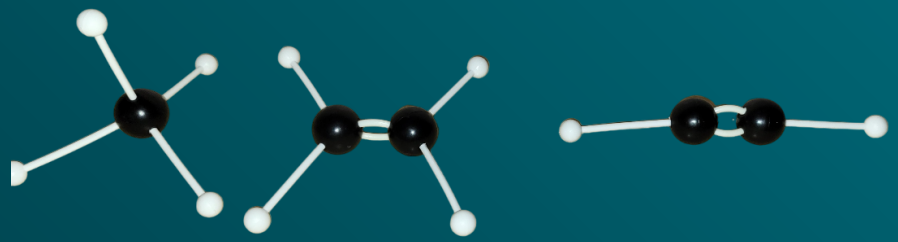
Octahydral

sp^2d^3 – pentagonal bipyramidal

Hybridization

sp, sp2, sp3, sp3d,
sp3d2, sp3d3

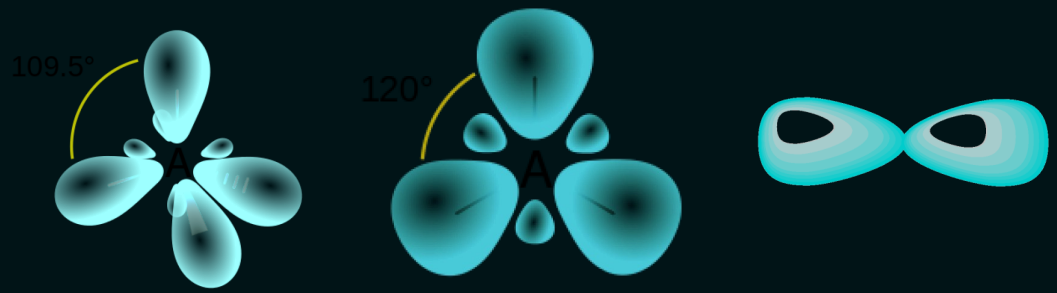
Identify with Super trick



C_2H_6 Alkane

C_2H_4 Alkene

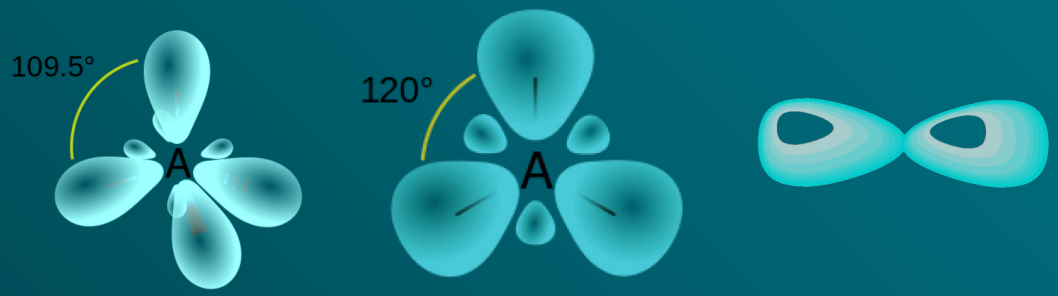
C_2H_2 Alkyne



B.Pharm. | POC-I | U 2 | L3

Hybridization

sp, sp2, sp3, sp3d, sp3d2, sp3d3
(Identify with Super trick)



B.Pharm. | POC-I | U 2 | L3

Hybridization

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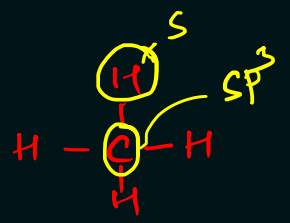
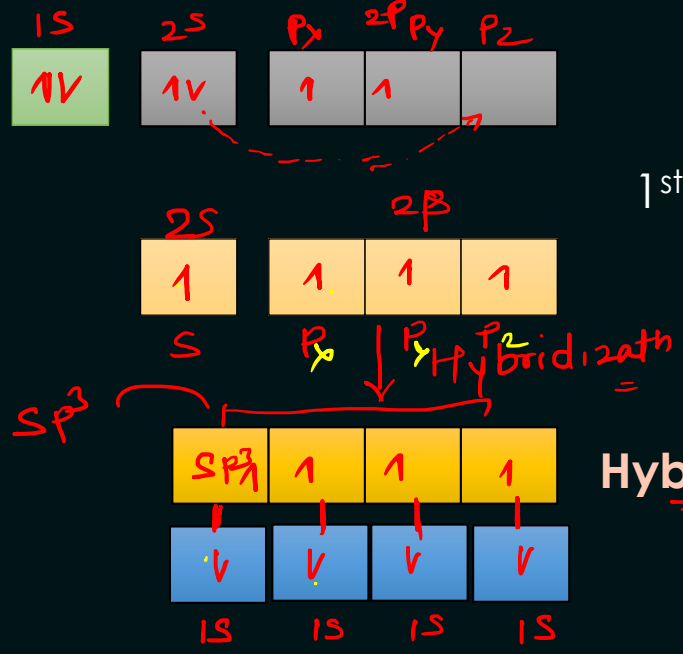
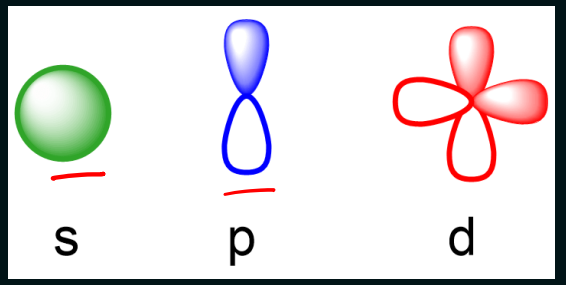


CH_4

C6 → $1S^2$ $2S^2$ $2P^2$

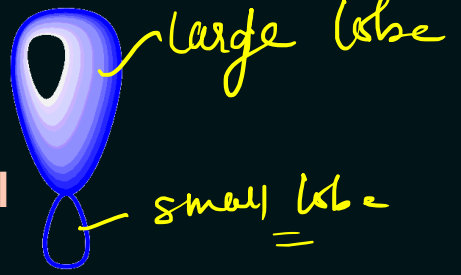
H1 → $1S^1$





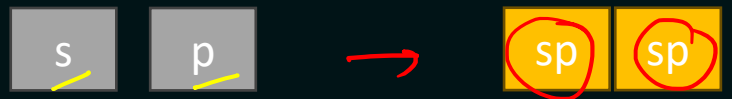
1st Excitation

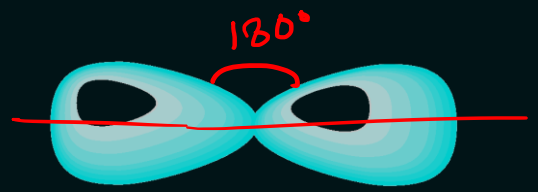
Hybrid Orbital



Hybridization

SP Hybridization





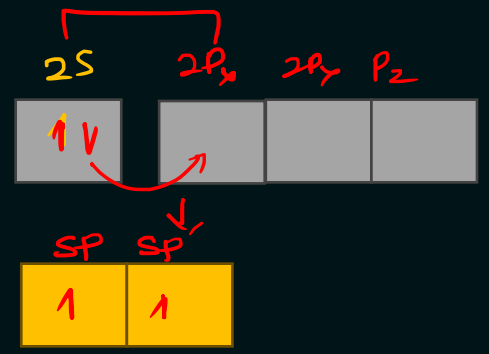
BA:180°

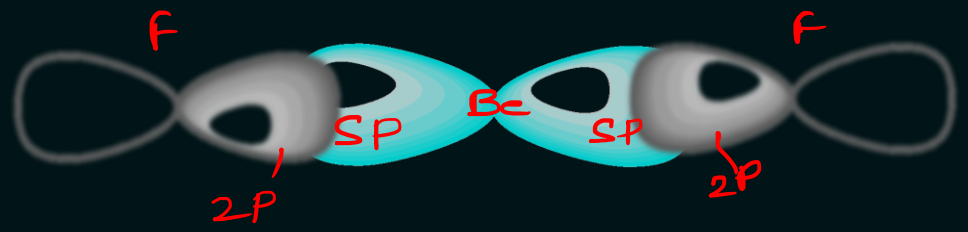
Linear Geometry

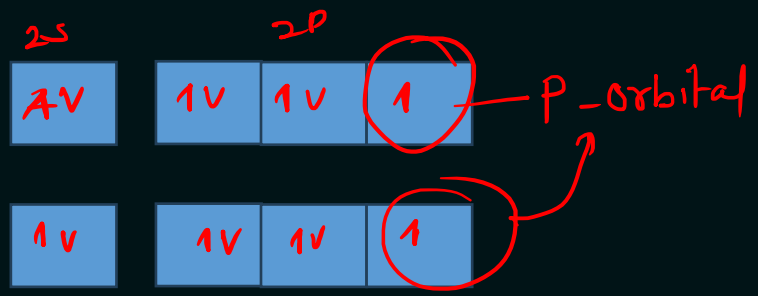
Example: Alkynes, BeF2, BeCl2

Be4 → $1S^2$ $2S^2$ $2P^0$

F9 → $1S^1$ $2S^2$ $2P^5$

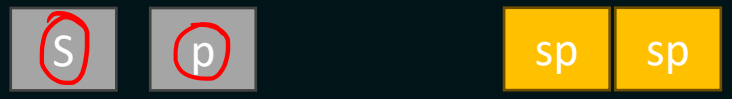


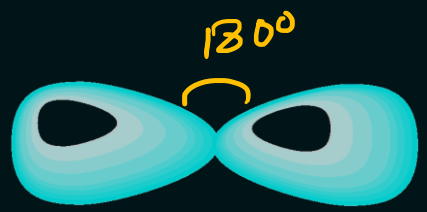




Hybridization

SP Hybridization



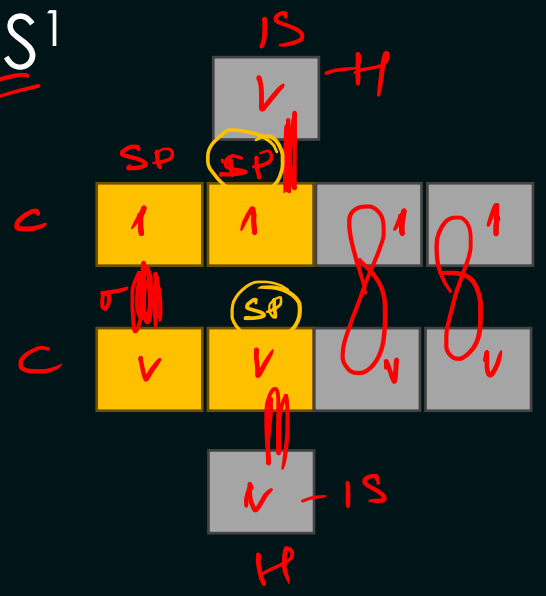


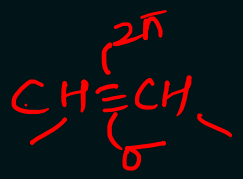
Linear

Example: Alkynes, BeF2, BeCl2

C6→ $1S^2\ 2S^2\ 2P^2$

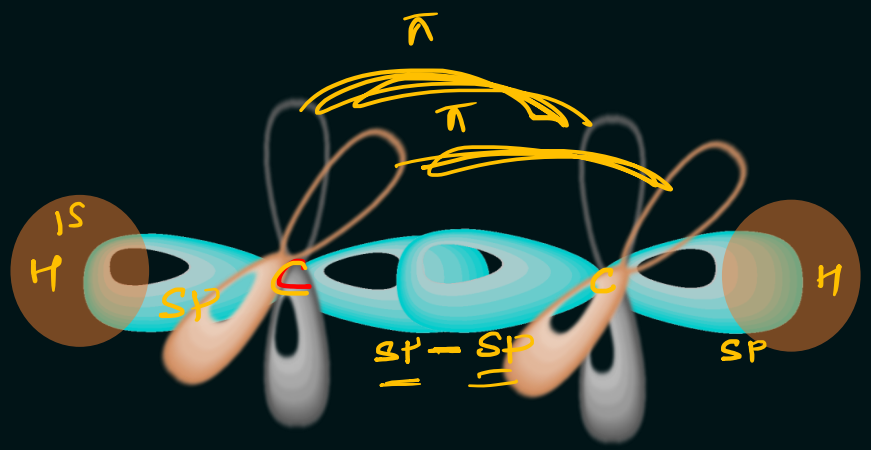
H1 → $1S^1$





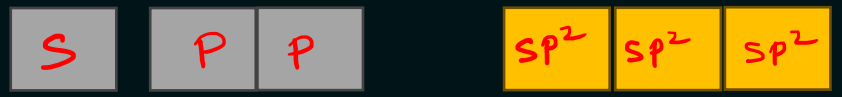
$HC \equiv CH$

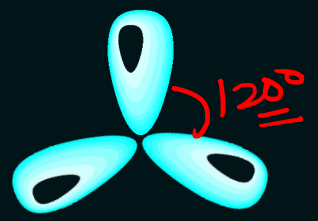
$H-C \equiv C-H$



Hybridization

SP2 Hybridization

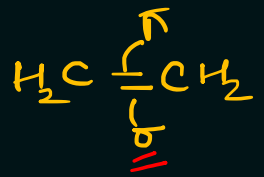


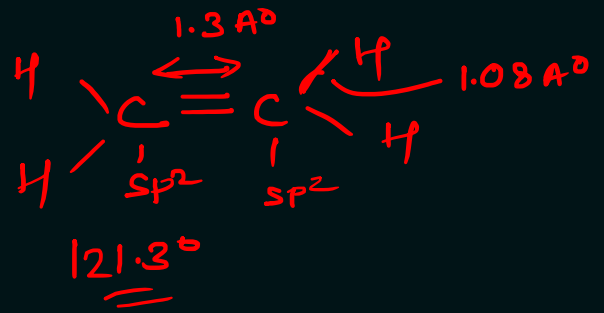


BA:120°

Trigonal Planer

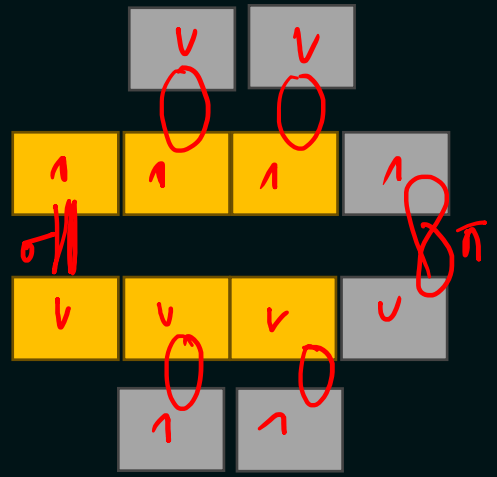
Example: Alkenes, BF3

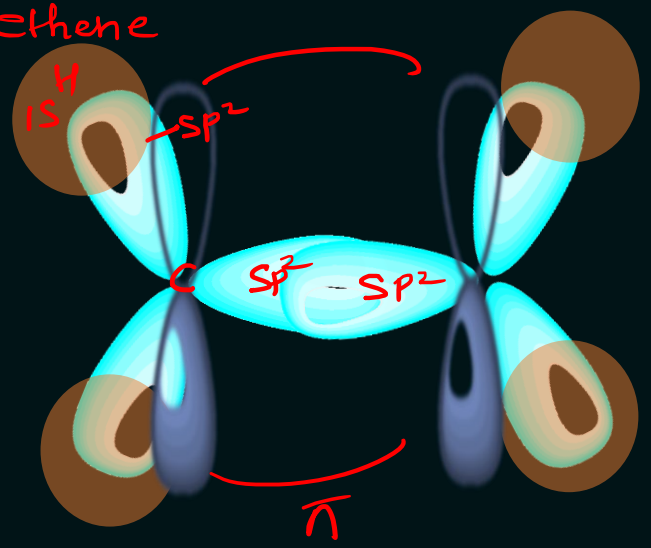




C6→ $1S^2$ $2S^2$ $2P^2$

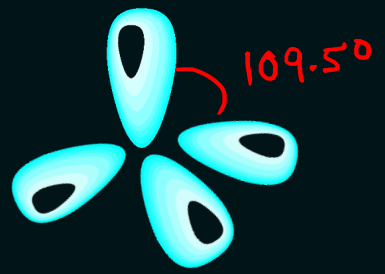
H1 → $1S^1$





Hybridization

SP3 Hybridization



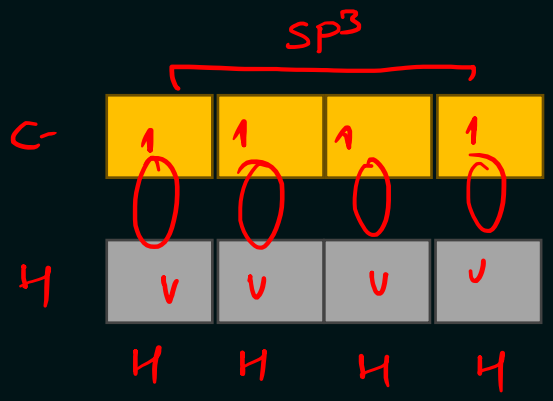
Tetrahedral

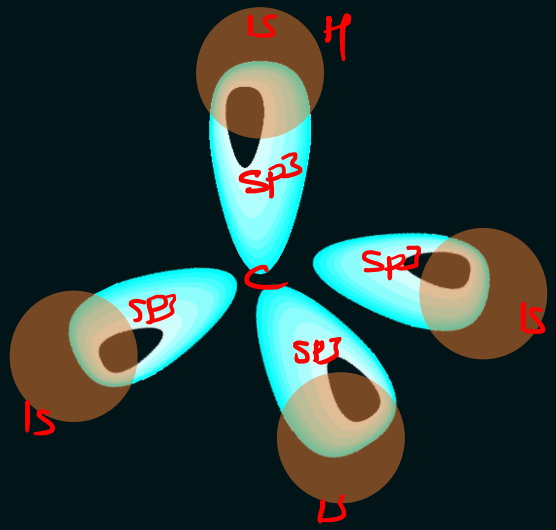
BA:109.5°

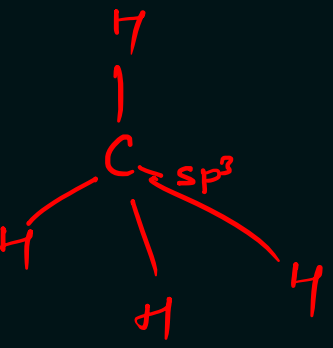
Example: Alkanes (Methane)

C6→ $1S^2$ $2S^2$ $2P^2$

H1 → $1S^1$

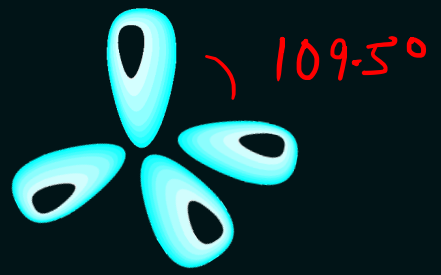




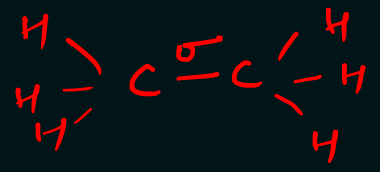


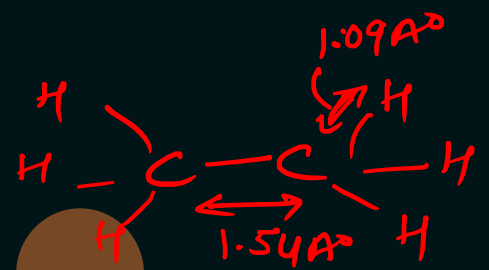
Hybridization

SP3 Hybridization



Tetrahedral

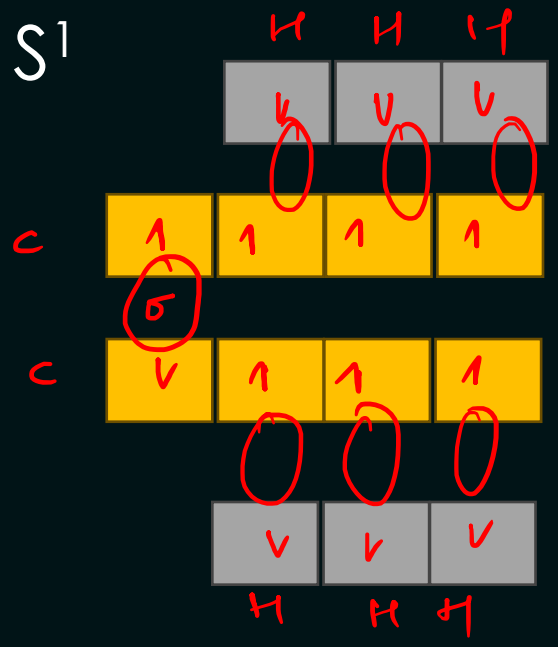


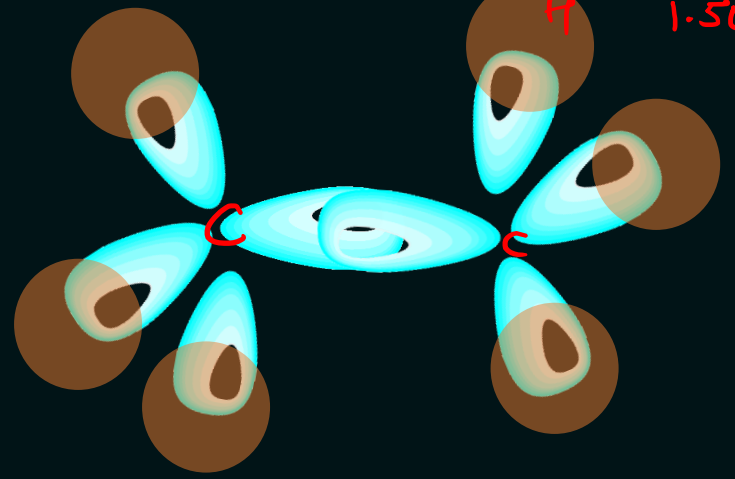


Example: Alkanes (Ethane)

C6→ $1S^2$ $2S^2$ $2P^2$

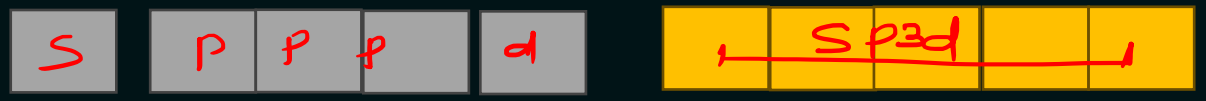
H1 → $1S^1$





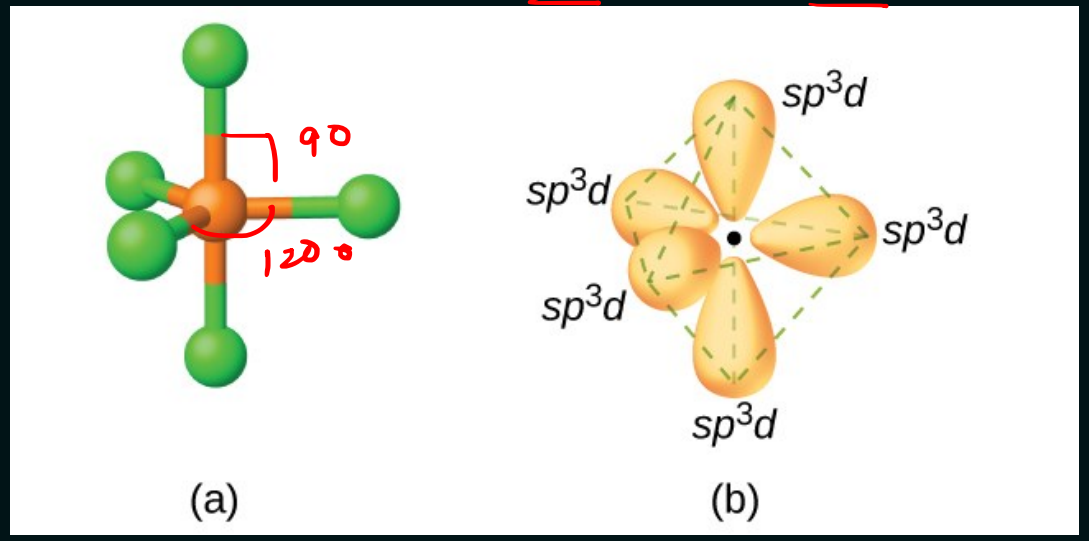
Hybridization

SP3d Hybridization



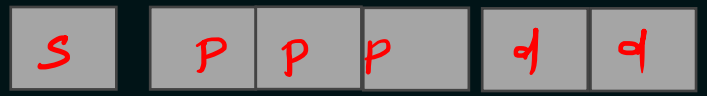
Example: PCl5

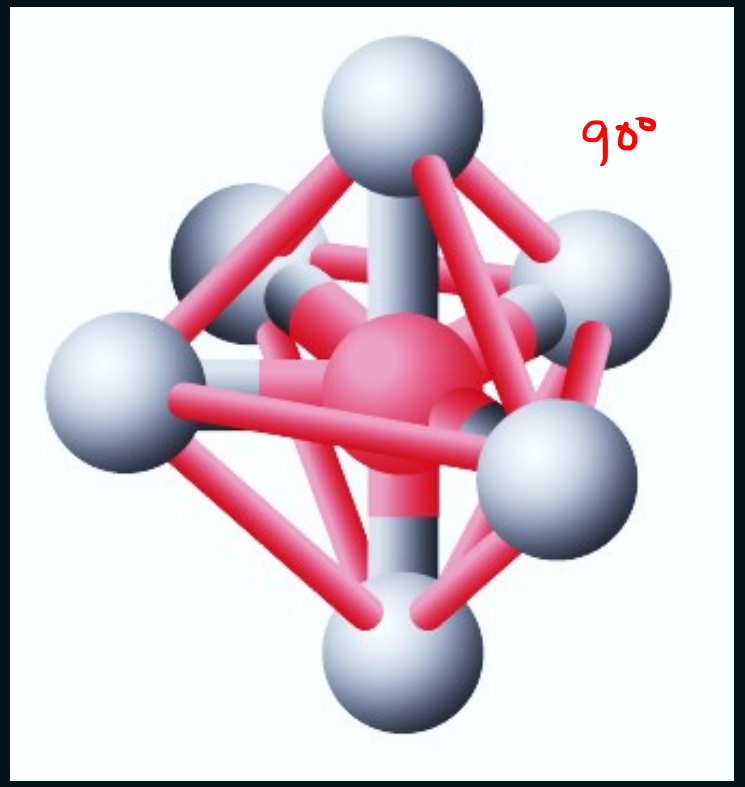
Trigonal Bipyramidal



Hybridization

SP3d2 Hybridization

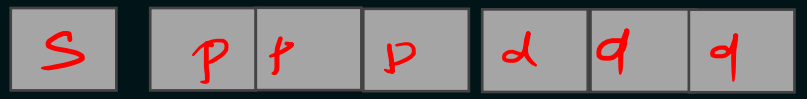


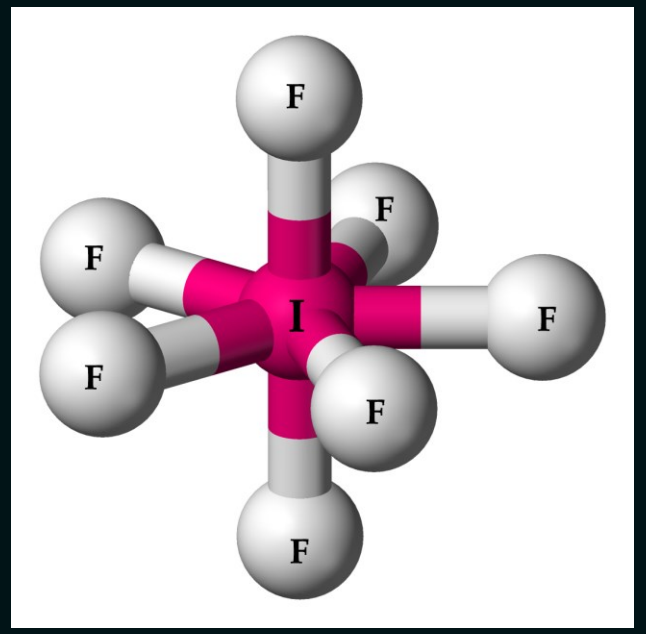


Octahedral

Hybridization

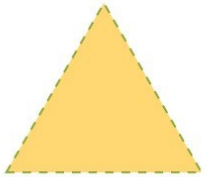
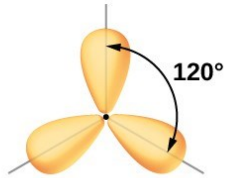
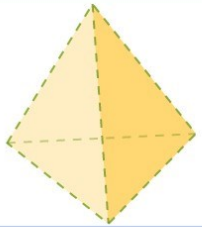
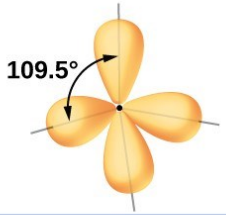
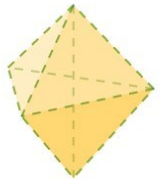
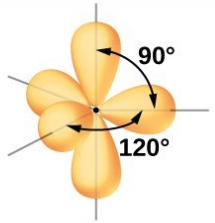
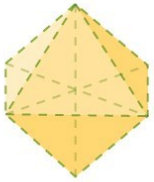
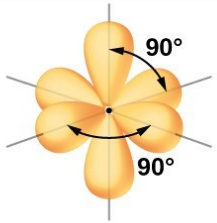
SP3d3 Hybridization





Pentagonal Bipyramidal

Hybridization

Regions of Electron Density	Arrangement		Hybridization	
2		linear	*sp*	
3		trigonal planar	sp^2	
4		tetrahedral	sp^3	
5		trigonal bipyramidal	sp^3d	
6		octahedral	sp^3d^2	

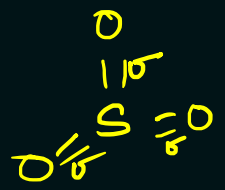
Hybridization

How Identify Hybridization (Trick)

- 1. By Structure- Sigma Bond & Lone Pair

  Z = Sigma Bond + no of Lone Pair at Central Atom

↳ SO_3



Z = 3 sp²

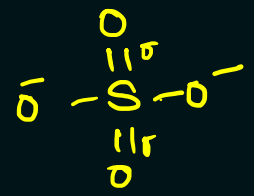
↳ H_2O

Z = 4 sp³

↳ NH_3

Z = 4 sp³

↳ SO_4^{2-}



4 sp³

Z =

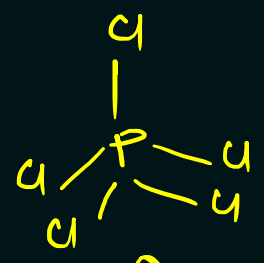
2	3	4	5	6
sp	sp2	sp3	sp3d	sp3d²

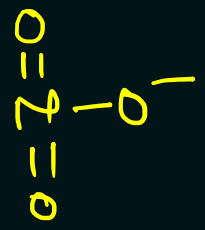
Valency	2	3	4	5	6
	Be	B	C	N	O
	Mg	Al	Si	P	S

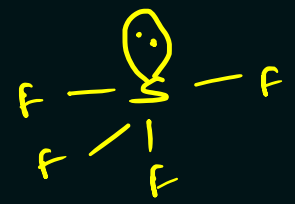
How Identify Hybridization (Trick)

- 1. By Structure- Sigma Bond & Lone Pair

Z = Sigma Bond + no of Lone Pair at Central Atom

↳ PCl_5 —  5 sp^3d

↳ NO_3^-  3 sp^2

↳ SF_4  5 sp^3d

2	3	4	5	6
sp	sp2	sp3	sp3d	sp3d

Valency	2	3	4	5	6
	Be	B	C	N	O
	Mg	Al	Si	P	S

Hybridization

How Identify Hybridization (Trick)

- **Z =** ½ [No. of valence electron in central atom + -ve Charged - +ve Charged + no of monovalent atom]

2	3	4	5	6
sp	sp2	sp3	sp3d	sp3d

Valency	2	3	4	5	6
	Be	B	C	N	O
	Mg	Al	Si	P	S

- NH_3 = $\frac{1}{2}[5+3] = \frac{8}{2} = 4$ sp^3
- H_2O $\frac{1}{2}[6+2]$ $\frac{8}{2} = 4$ sp^3
- PCl_5 $\frac{1}{2}(5+5]$ $\frac{10}{2}$ 5 sp^3d
- CO_3^{2-} $\frac{1}{2}(4+2)$ $\frac{6}{2} = 3$ sp^2
- NO_3^- $\frac{1}{2}(5+1)$ $\frac{6}{2} = 3$ sp^2