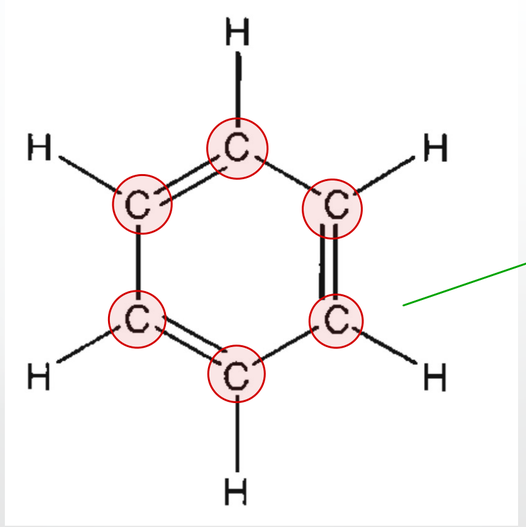
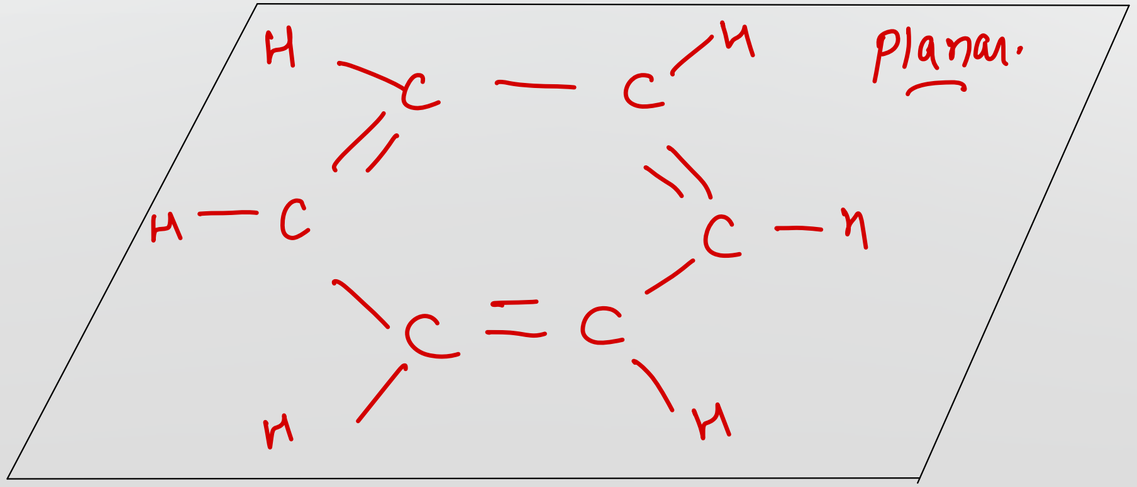
Find the hybridisation of all the Carbon in the structure given below



Benzene
(C6H6)

**All carbon are Sp2 Hybridized



Solid state Hybridisation.

Hybridisation in ionic solid species

Species	***Cationic part***	***Anionic part***
PCl_5	PCl_4^+ (sp^3)	PCl_6^- (sp^3d^2)
PBr_5	PBr_4^+ (sp^3)	Br^-
XeF_6	XeF_5^+ (sp^3d^2)	F^-
N_2O_5	NO_2^+ (sp)	NO_3^- (sp^2)
I_2Cl_6 (liquid)	ICl_2^+ (sp^3)	ICl_4^- (sp^3d^2)
Cl_2O_6	ClO_2^+ (sp^2)	ClO_4^- (sp^3)

Hybridisation in ionic solid species

HW

Species.	Cation	Anion.	Hyb(cation).	Hyb (anion)
N_2O_4	$[NO]^+$	$[NO_3]^-$	———	
N_2O_3	$[NO]^+$	$[NO_2]^-$	———	
BrF_3	$[BrF_2]^+$	$[BrF_4]^-$		———
IF_5	$[IF_4]^+$	$[IF_6]^-$		
ICl	$[I_2Cl]^+$	$[ICl_2]^-$		
I_4O_9	$[I]^{3+}$	$[IO_3^-]_3$	———	
I_2	$[I_3]^+$	$[I_3]^-$		

Practice Question

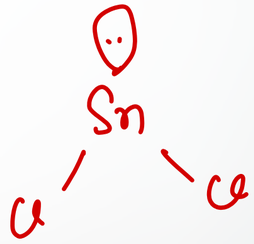
Which of the following species are isostructural?

× (A) SO_2 and SO_3

✓ (B) XeF_2 and I_3^-

✓ (C) $SnCl_2$ and SO_2

× (D) SF_4 and CH_4



@ SO_2 - Bent

SO_3 - Trigonal planar.

(b) XeF_2 - linear

I_3^- - linear

(c) $SnCl_2$ - Bent

SO_2 - Bent

(d) SF_4 - See - Saw

CH_4 - tetrahedral.

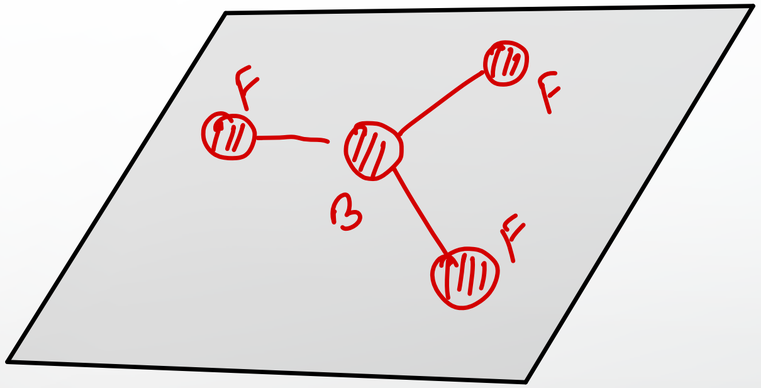
(Q) Identify planar and non planar species among the following

C_6H_6 (Benzene), CO_2 , SO_2 , H_2O , CH_4 ,XeF_2 , $\bar{I}3$, BF_3, ClF_3, SF_6, XeF_4 , XeO_4,

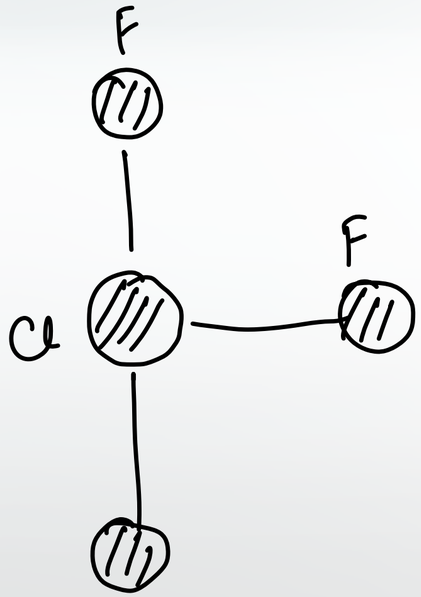
SO_4^{2-}, PO_4^{3-}, MnO_4^-,

tetrahedral.

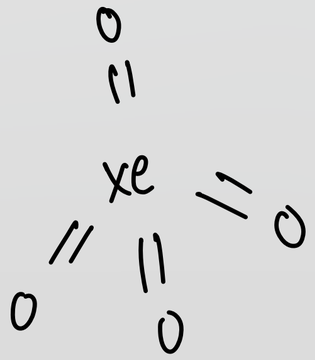
1. Benzene - planar.
2. CO_2 - planar.
3. SO_2 - planar.
4. H_2O - planar.
5. CH_4 - non - planar.
6. XeF_2 - planar.
7. I_3^- - planar
8. BF_3 - planar.
9. ClF_3 - planar.
10. SF_6 - non - planar
11. XeF_4 - planar.
12. XeO_4 - non - planar
13. SO_4^{2-} - non - planar.
14. PO_4^{3-} - non - planar.
15. MnO_4^- - non - planar.
16. SF_4 - non - planar.



Trigonal planar.



planar



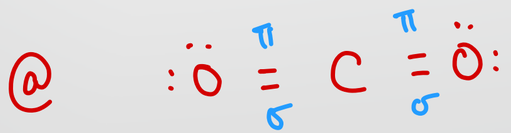
(Q) In which of the following molecule Pπ-Pπ as well as dπ-Pπ bonds are present.

(a) CO2

(b) XeO3

(c) XeO2F2

(d) SO3

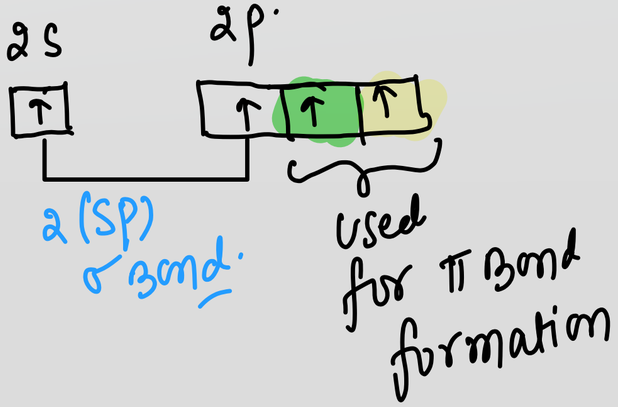


@ $:\ddot{O}=C=\ddot{O}:$

σ Bond. (Hyb: sp)

C (Hyb) : sp

2 (pπ - pπ) Bond



(b)

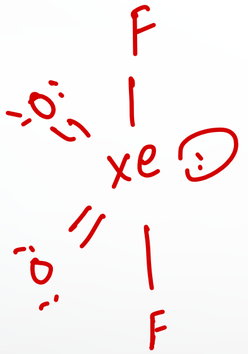
Hyb: sp^3

SN = 3 + 1 = 4.

π Bond.

3 (dπ - pπ)

(c)

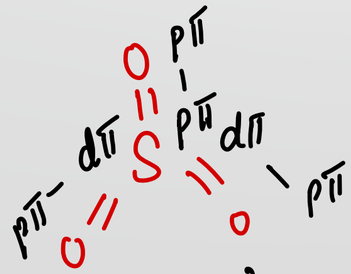


Hyb: sp^3d.

π Bond formed

2 (dπ - pπ)

(d)



Hyb: sp^2

π Bond.

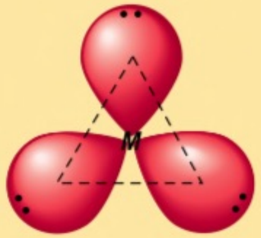
(pπ - pπ) - 1 & (dπ - pπ) - 2

Chemical Bonding

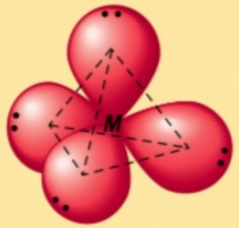
Type of hybridisation

Equivalent

Linear



Planar triangular

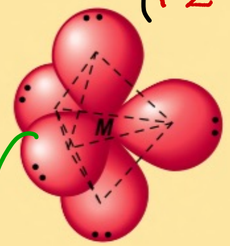


Tetrahedral
(A tetrahedron is pyramid shaped. It has four triangular faces and four corners.)

Octahedral
(An octahedron is an eight-sided figure with *six* corners. It consists of two square pyramids that share a common square base.)

Non equivalent

(Pz + dz2) 0/0 p & d = 50

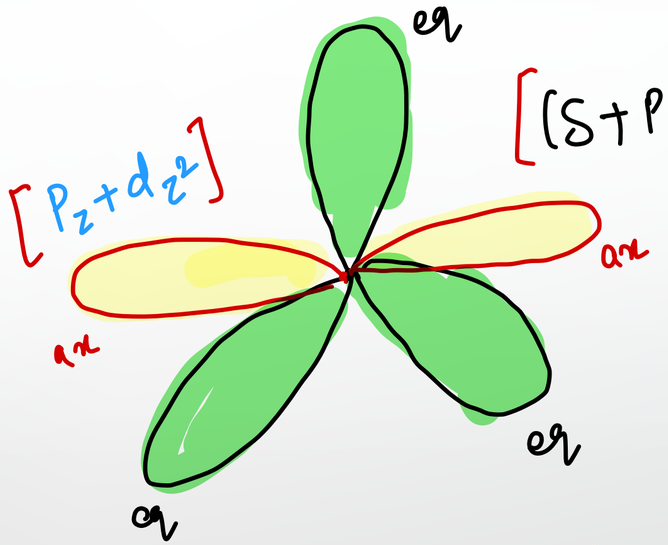


Trigonal bipyramidal
(This figure consists of two three-sided pyramids joined by sharing a common face—the triangular plane through the center.)

S + Px + Py

0/0 S = 33.33

$sp^3d \rightsquigarrow (S + P_x + P_y + P_z + d_{z^2})$



sp^2

% s character $= \frac{1}{3} \times 100$

$= 33.33\%$

% p character $= \frac{1}{2} \times 100$

$= 50\%$

% d character $= \frac{1}{2} \times 100$

$= 50\%$

Chemical Bonding

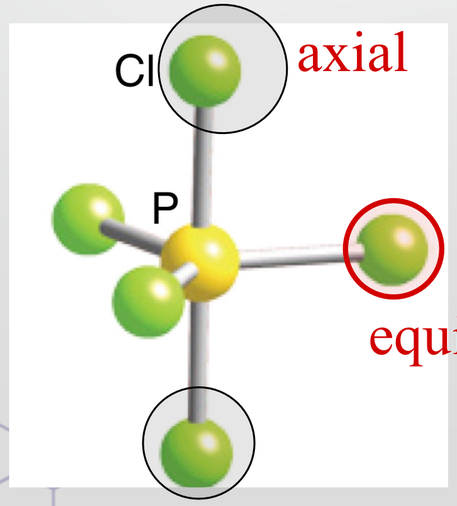
Bent's Rule

** Failure of previous theory

$$PCl_5\,(g) \rightleftharpoons PCl_3\,(g) + Cl_2\,(g)$$

(Q) If all bond are Sp3d - 3p why bond strength are different?

Ans: This is because of difference of S character in hybrid orbital



$$\cos\theta = \frac{S}{S-1}$$

*Eq bond angle 120°

% S character= 33.33%

$$\cos\theta = \frac{P-1}{P}$$

*Axial bond angle $=90^{0}$

% S character = 0 %

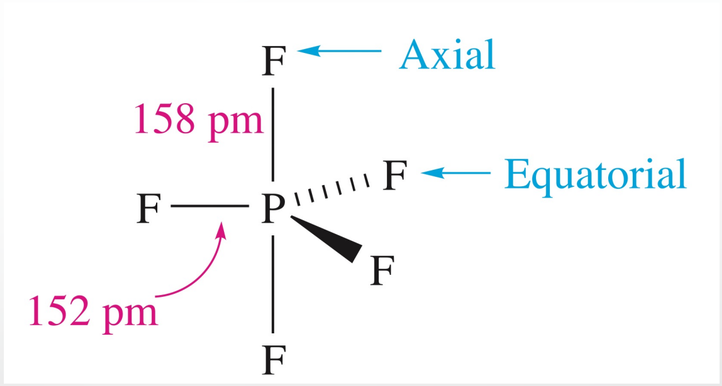
$90^{\circ} \leq \theta \leq 180^{\circ}$

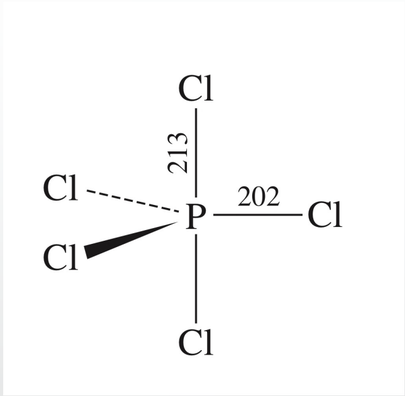
to calculate % character in bonds

**important point : B.A↑ %Scharacter↑ * BL↓ BS↑

Length of hybrid orbital

B.L = length of hybrid orbital + Size of C.A/S.A

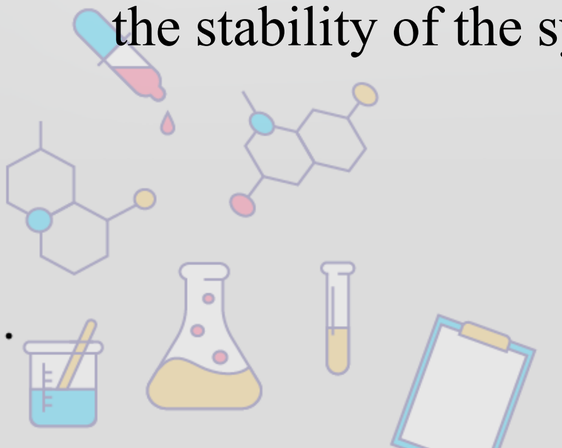




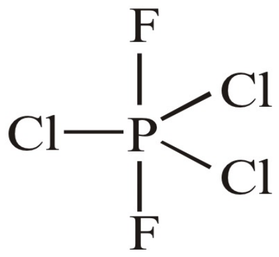
Bent's Rule

** **A lone pair of electron prefers to occupy that hybrid orbitals which has greater percentage of s-character.**
(As s-orbital is more close to nucleus, the electron pair present in s-orbital will experience more attraction of the nucleus, i.e. stability of the system increases).

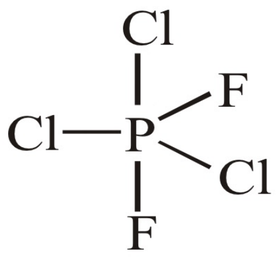
**A more electronegative atom/group prefers to overlap with that hybrid orbital which has smaller percentage of S character .
(A more electronegative atom has tendency to attract the shared pair of electron towards itself ,thus relatively more distant from the nucleus of central atom by doing so it increases the stability of the system)



(Q) Draw the geometry of PCl_3F_2



Correct Structure



Wrong Structure

Because highly electronegative atom occupy axial position (axial position has smaller percentage of s-character).

Bent's Rule

** 'More electronegative atom prefer to stay in the orbital having more p character and can also increase the P character in it's attached orbital from the central atom. '

* The rule can be applied to explain the effect of electronegativity on bond angle and bond length

Application of Bent's Rule

(Q) Compare C–C bond length in C_2H_6 and C_2Cl_6

In C_2H_6 and C_2Cl_6 both carbon atom are sp^3 hybrid and there is no lone pair of electron on central atom, but all the four sp^3 hybrid orbital around any of the carbon are non-equivalent.

In C_2H_6 molecule, to one of the C-atom three hydrogen atom (less electronegative) and one carbon atom (more electronegative than H) is attached. According to Bent rule, more electronegative carbon will overlap with that hybrid orbital has less character of s-character.