Theories covered

Valence Bond Theory (Hybridization) Topics

Concept Video

Formation of covalent bonds (single bonds/ sigma bonds)

Formation of covalent bonds (multiple bonds/ sigma and pi bonds)

Concept Video

Hybridization of orbitals 1

Concept Video

Hybridization of orbitals 2

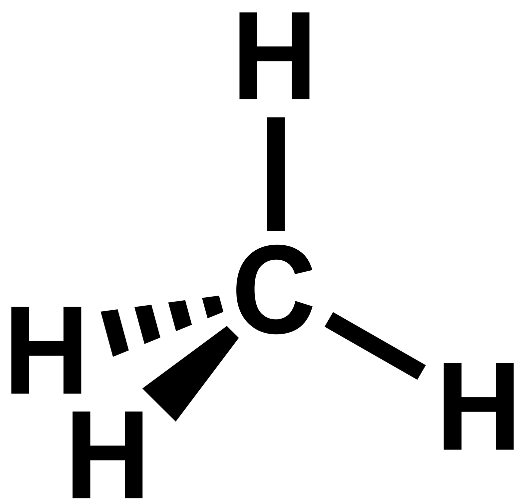
Tetrahedral Geometry

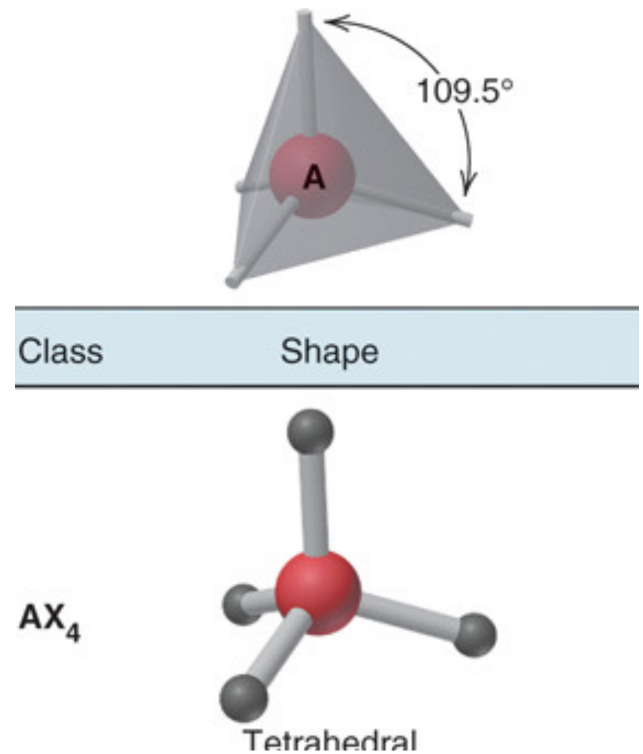
Tetrahedral Geometry (AX_4)

4 electron groups : 4 bonding groups (no lone pairs)

Bond Angle (XAX): 109.5˚

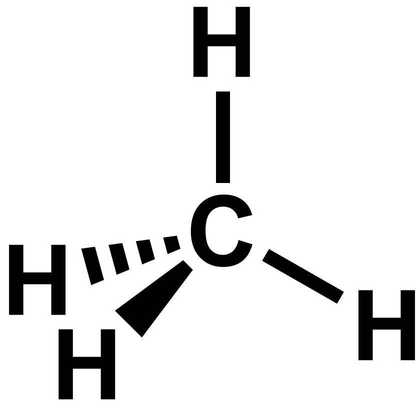
e.g. CH_4



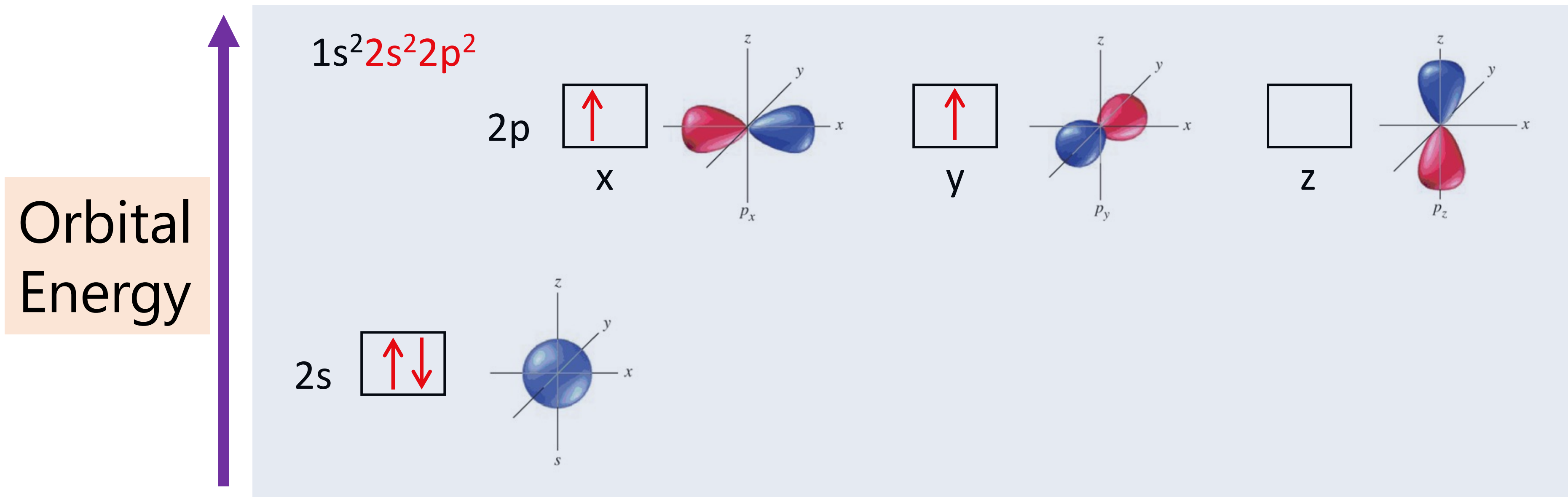


Hybridization for 4 electron groups

e.g. CH_4

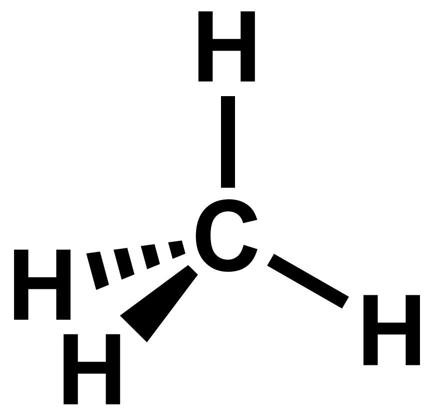


Mix <u>four</u> valence orbitals to get <u>four</u> equivalent hybrid orbitals



Hybridization for 4 electron groups

e.g. CH_4



Mix four valence orbitals to get four equivalent hybrid orbitals

(s:p = 1:3 = "sp^3")

Orbital Energy

$1s^2 2(sp^3)^4$

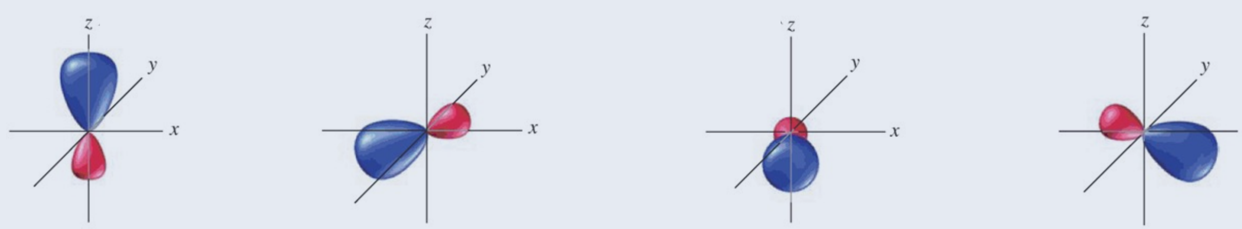
sp^3 Hybrid Orbitals

sp^3 ↑

sp^3 ↑

sp^3 ↑

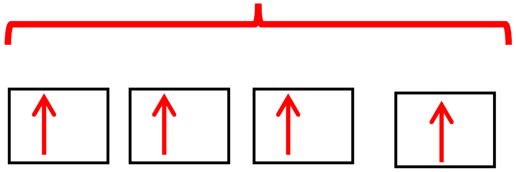
sp^3 ↑

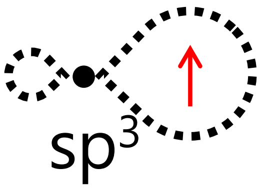


Depicting bond formation with hybrid orbitals

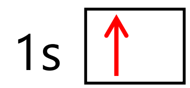
Carbon atom

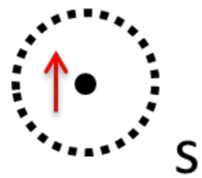
sp³





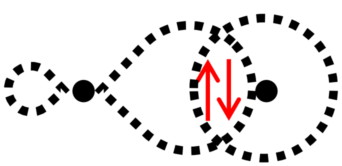
Hydrogen atom

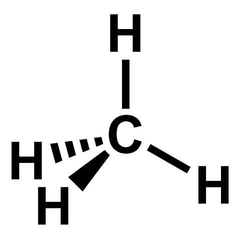


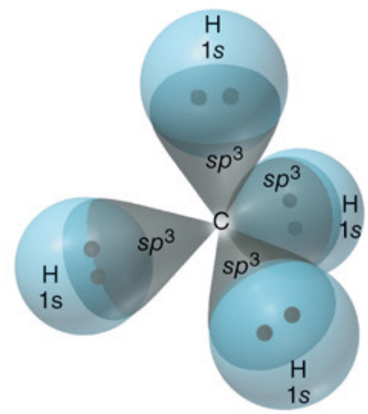


<u>Four</u> IDENTICAL "sp³-s" σ-bonds

<u>ONE</u> C-H sp³-s σ-bond:



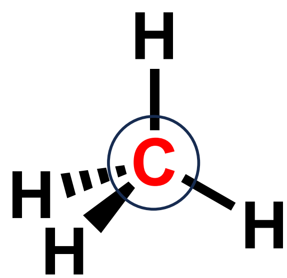
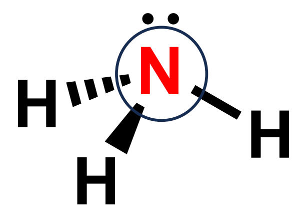
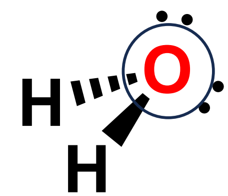




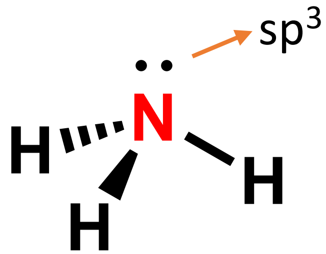
Hybridization: Lone Pairs

Mixing of valence orbitals in an element to obtain orbitals with appropriate geometry

Number of electron groups = number of hybrid orbitals

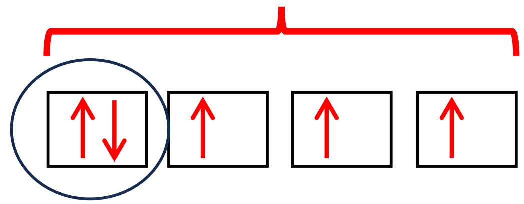
			
#Electron groups	**4**	**4**	**4**
#Hybrid Orbitals	**4**	**4**	**4**
Hybridization	sp^3	sp^3	sp^3

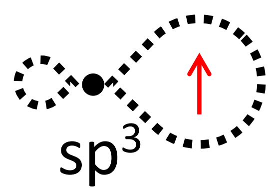
Hybridization: Lone Pairs (Practice NH_3)



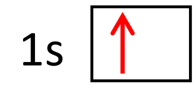
Nitrogen atom

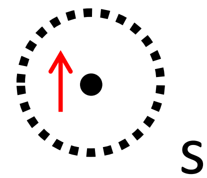
sp^3



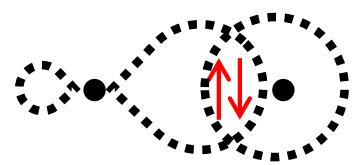


Hydrogen atom





3 sp^3– s σ bonds



McGill

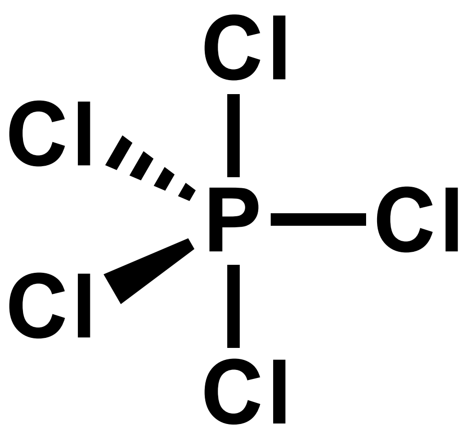
Trigonal Bipyramidal Geometry

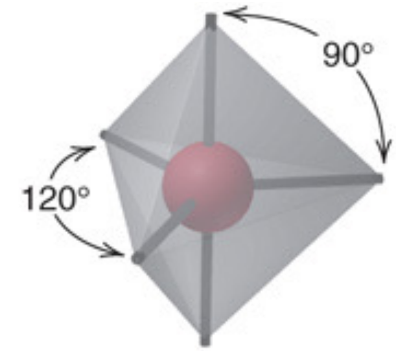
Trigonal Bipyramidal Geometry (AX_5)

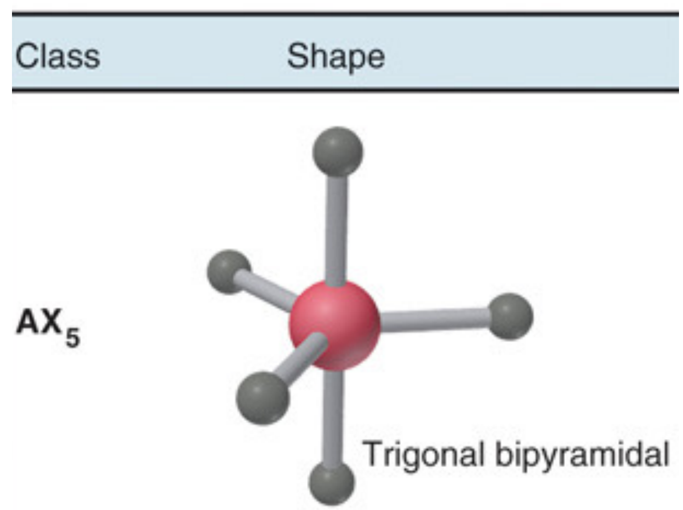
5 electron groups : 5 bonding groups (no lone pairs)

Bond Angle (XAX): 120 and 90

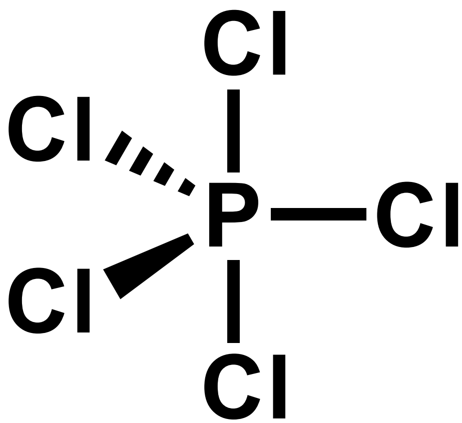
e.g. PCl_5



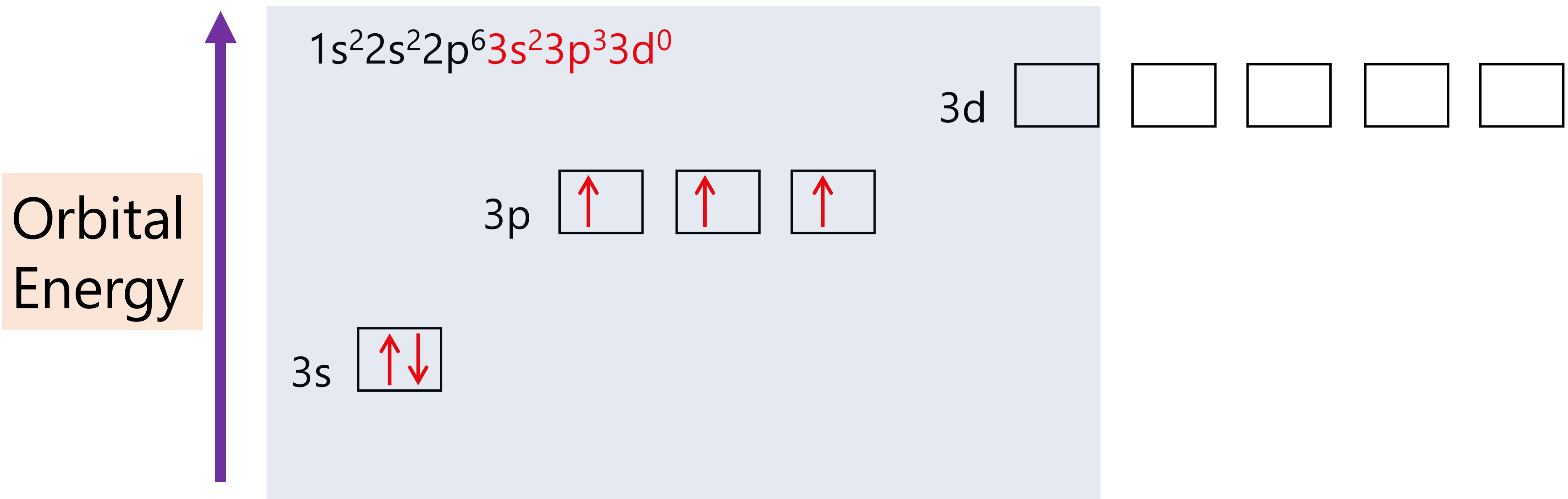




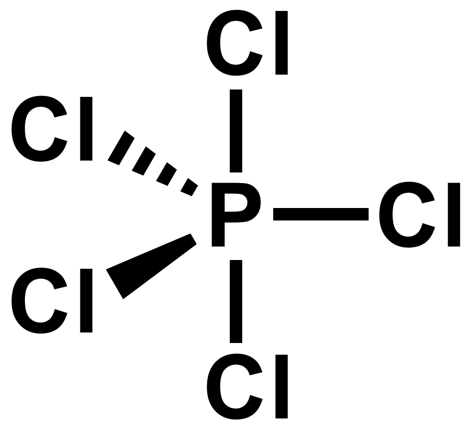
Hybridization for 5 electron groups



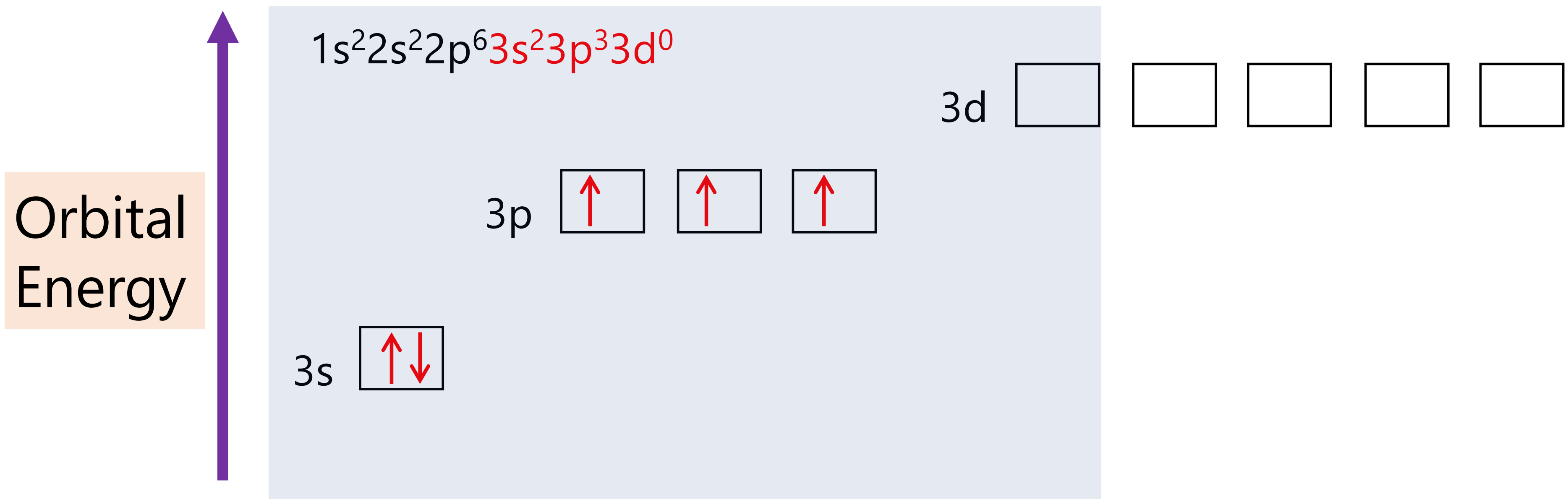
Mix five valence orbitals to get five equivalent hybrid orbitals



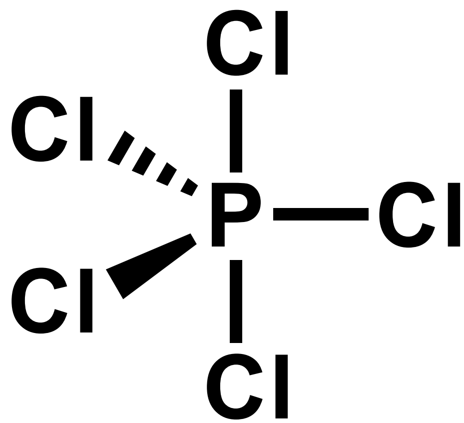
Hybridization for 5 electron groups



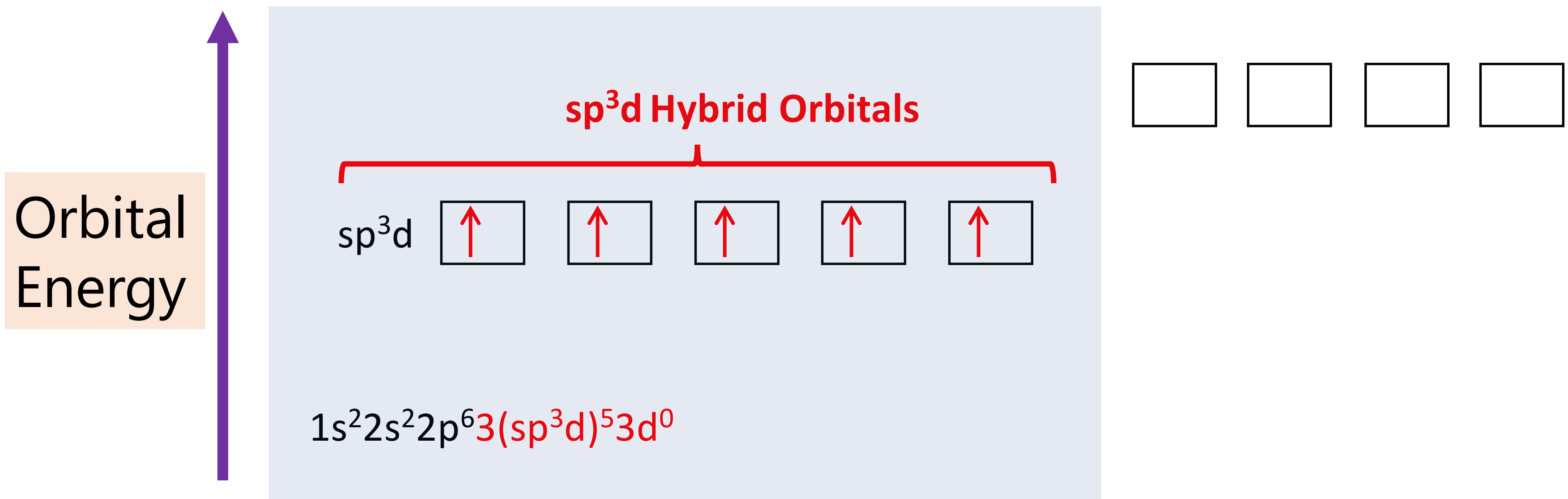
Mix <u>five</u> valence orbitals to get <u>five</u> equivalent hybrid orbitals



Hybridization for 5 electron groups



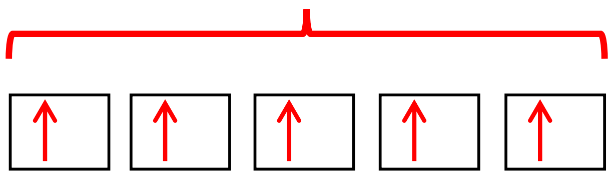
Mix <u>five</u> valence orbitals to get <u>five</u> equivalent hybrid orbitals

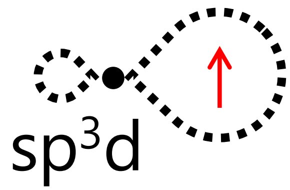


Depicting bonds in sp^{3}d hybrid orbitals

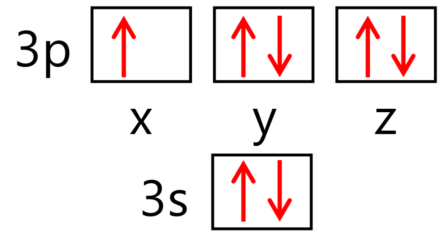
Phosphorus atom

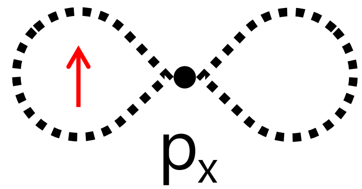
sp^{3}d



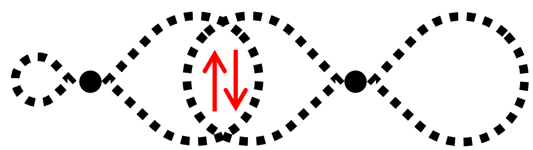


Chlorine atom





ONE P-Cl **'sp^{3}d-p' σ-bond**:



FIVE IDENTICAL
'sp^{3}d-p' σ-bonds

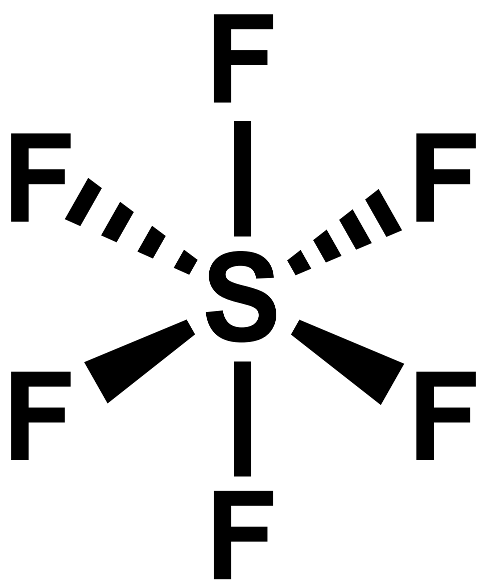
Octahedral Geometry

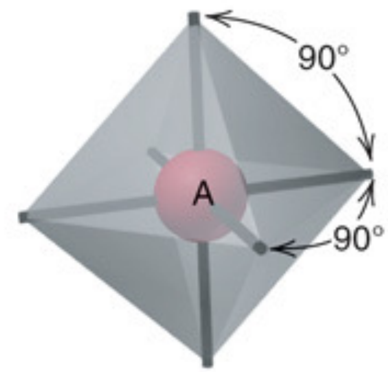
Octahedral Geometry (AX_6)

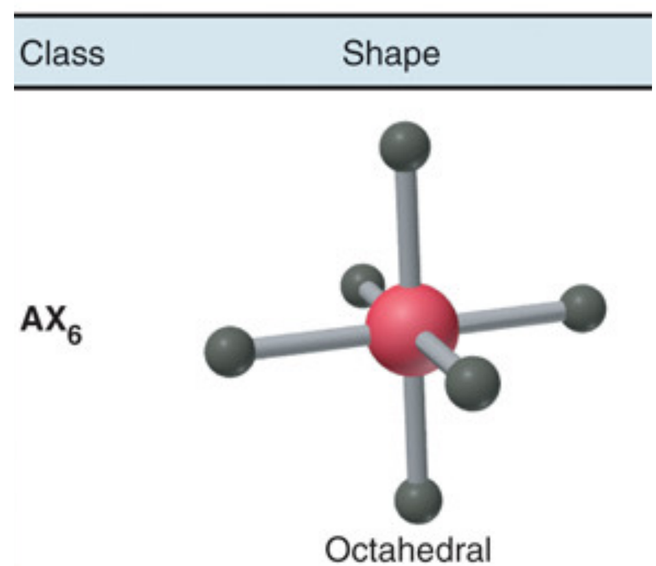
6 electron groups : 6 bonding groups (no lone pairs)

Bond Angle (XAX): 90

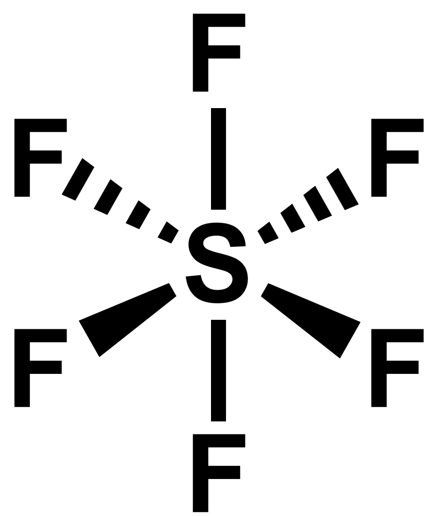
e.g. SF_6



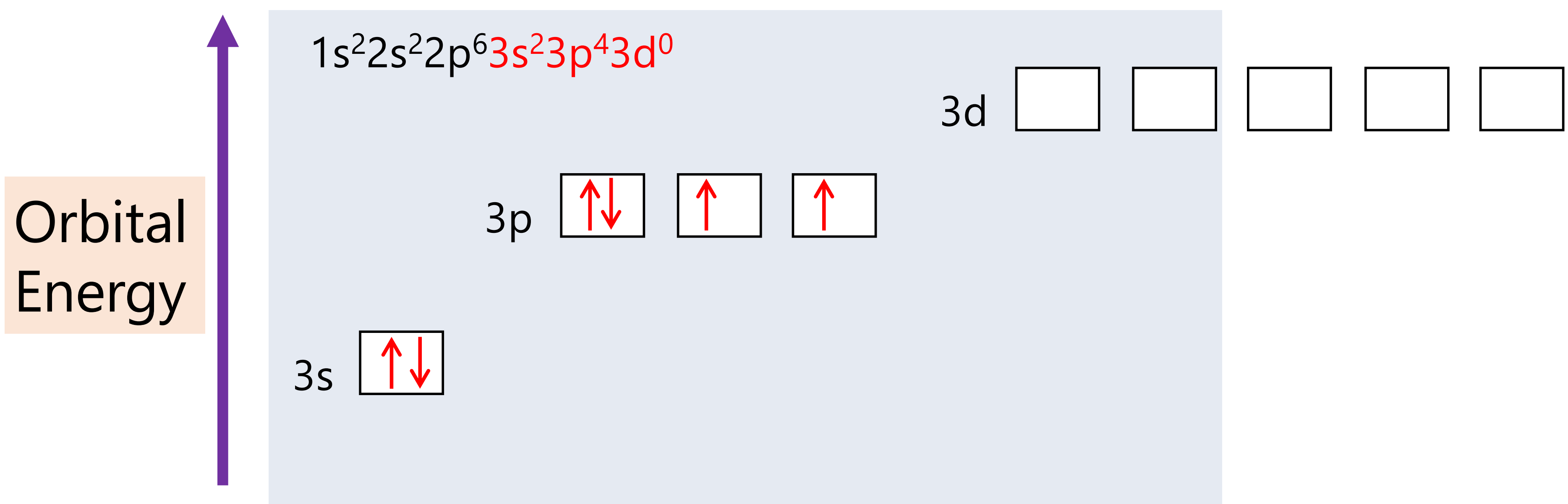




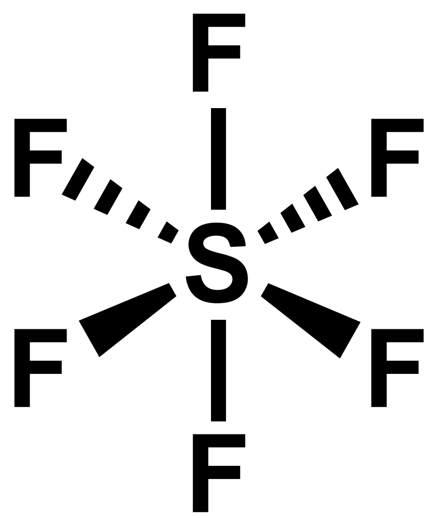
Hybridization for 6 electron groups



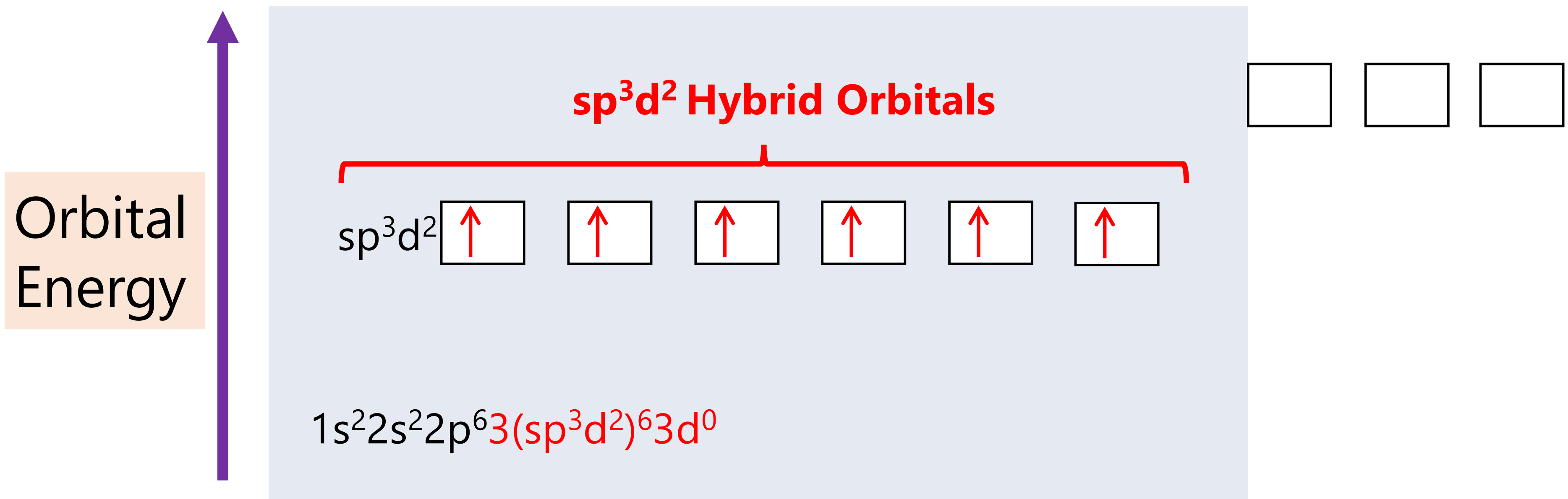
Mix <u>six</u> valence orbitals to get <u>six</u> equivalent hybrid orbitals



Hybridization for 5 electron groups

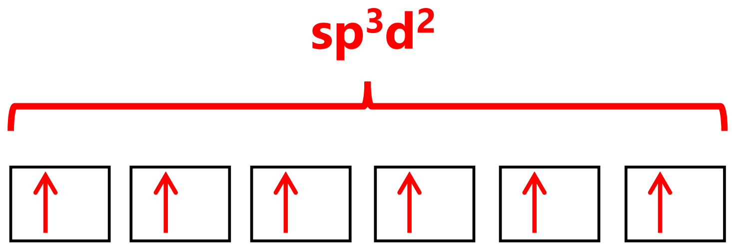


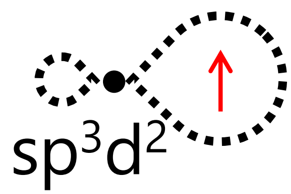
Mix six valence orbitals to get six equivalent hybrid orbitals



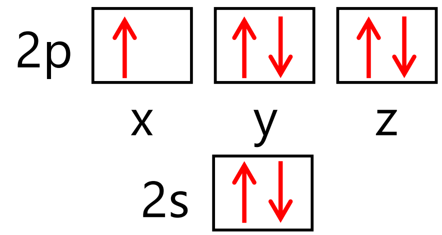
Depicting bonds in sp^3d^2 hybrid orbitals

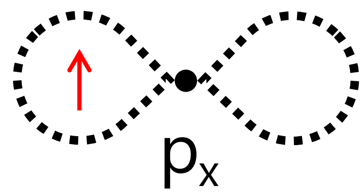
Sulfur atom



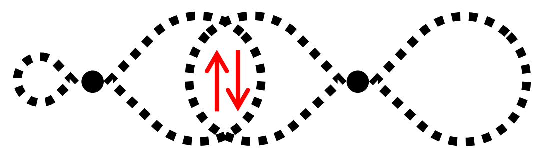


Fluorine atom





<u>EACH</u> S-F 'sp³d²-p' σ-bond:



SIX IDENTICAL
'sp^3d^2-p' σ-bonds