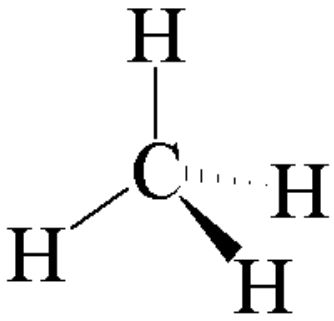
VSEPR Theory

Valence-Shell Electron-Pair Repulsion Theory
Repulsion between electron pairs causes molecular shapes to adjust so that the valence-electron pairs are as far apart as possible.

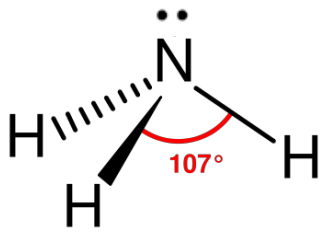
Ex. CH_4



tetrahedral angle (109.5°)

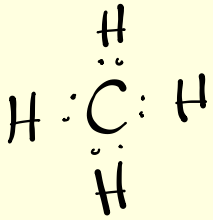
Ex. NH_3

Lone pairs (unshared pairs) also affect the shapes of molecules.

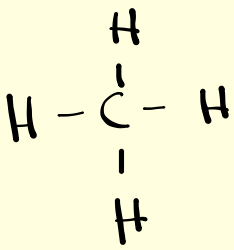


VSEPR

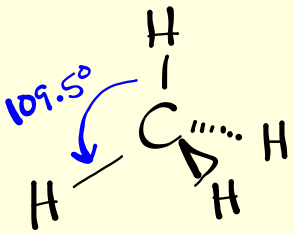
CH_4



2-D

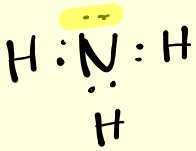


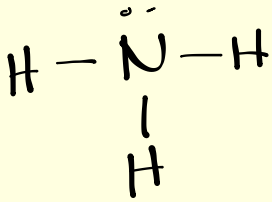
3-D



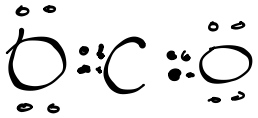
tetrahedral

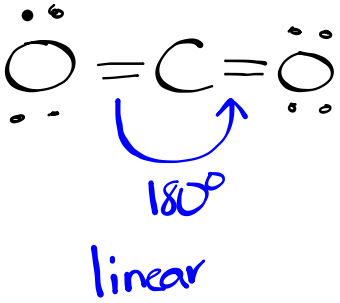
NH_3





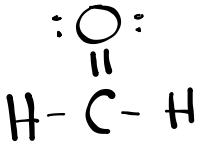
Ex. CO_2



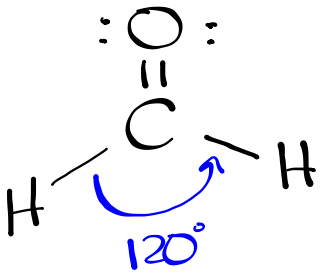


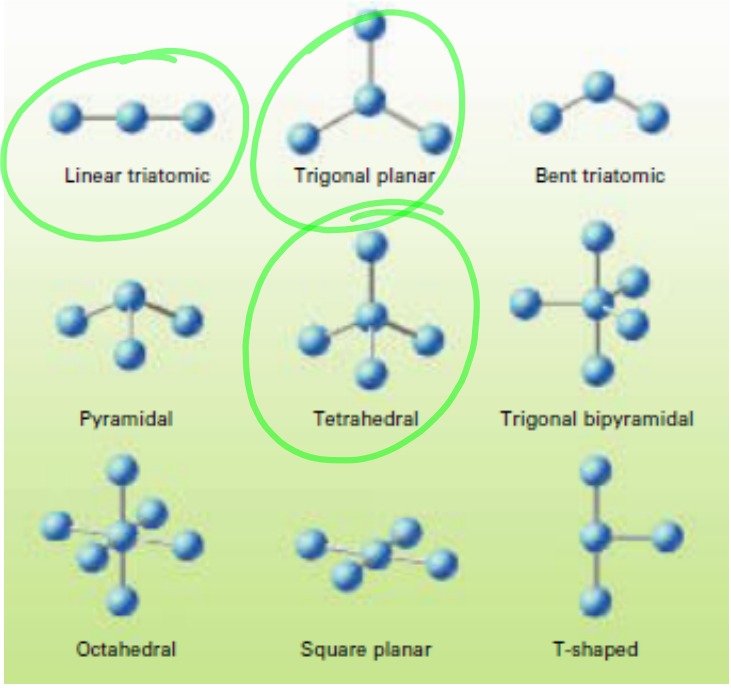
Ex. CH_2O

2-D



3-D



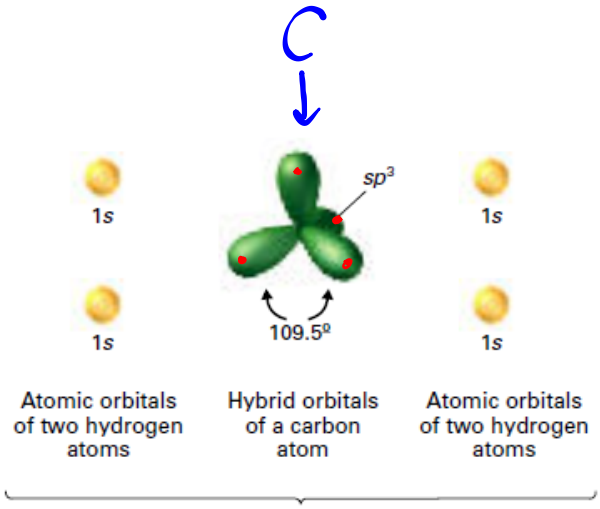

Linear triatomic
Trigonal planar
Bent triatomic
Pyramidal
Tetrahedral
Trigonal bipyramidal
Octahedral
Square planar
T-shaped

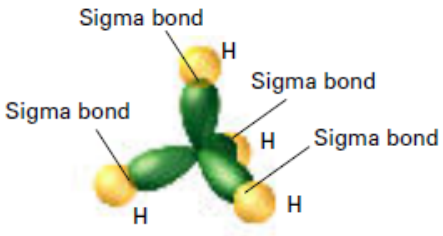
Hybridization Involving Single Bonds

In **hybridization**, atomic orbitals mix to form the same total number of equivalent hybrid orbitals.

Ex. CH_4

The one *2s* orbital and three *2p* orbitals of a carbon atom mix to form four sp^3 hybrid orbitals.





Methane molecule

CH_4

2p 1 1 1 ∞ 8

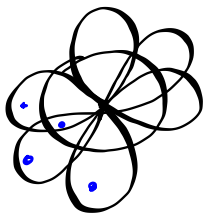
2s 1 ∞ 0

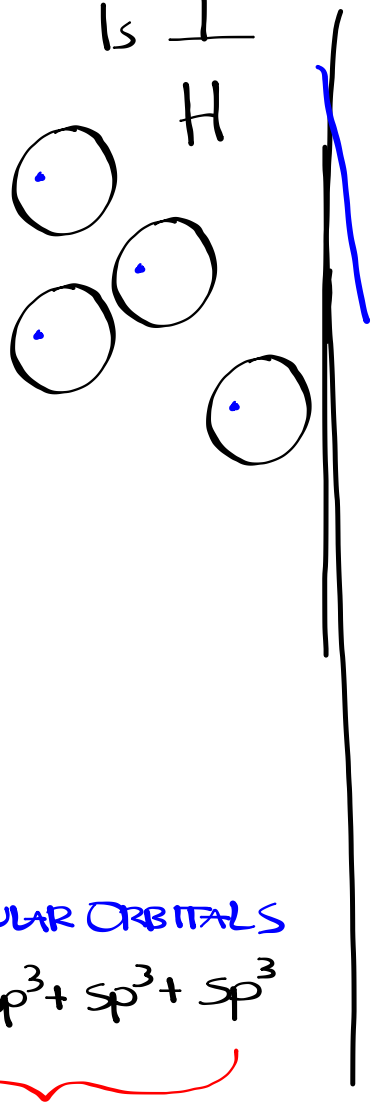
1s 1↓

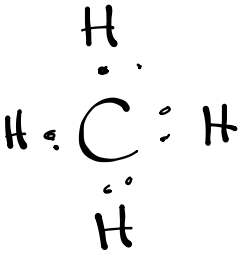
C

1s 1

H







ATOMIC ORBITALS

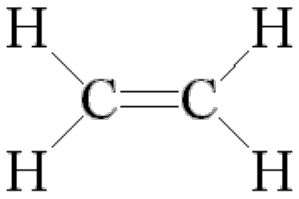
$S + p_x + p_y + p_z$ ⟶ $sp^3 + sp^3 + sp^3 + sp^3$

MOLECULAR ORBITALS

4 σ bonds

Hybridization Involving Double Bonds

Ex. C_2H_4

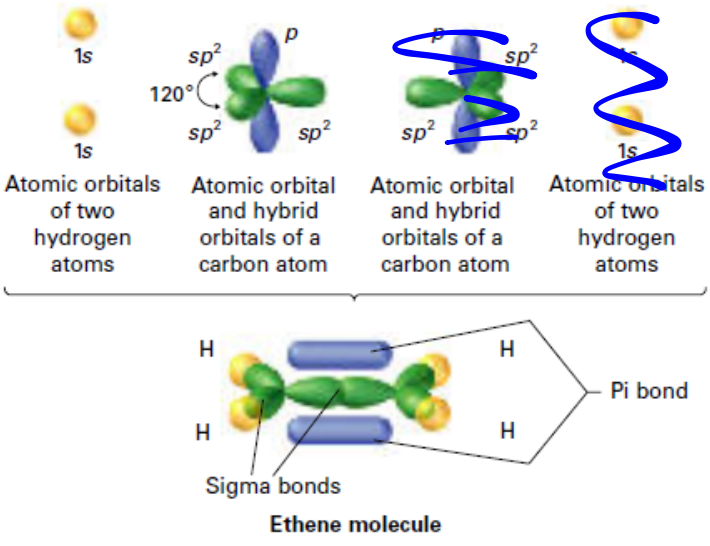


The one *2s* orbital and two *2p* orbitals of each carbon atom mix to form three sp^2 hybrid orbitals.

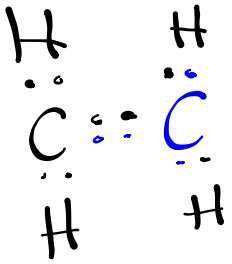
Two of the sp^2 orbitals overlap with the *1s* hydrogen orbital to form carbon-hydrogen sigma bonds.

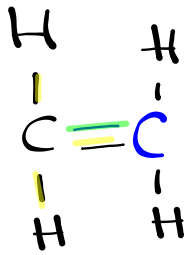
The third sp^2 orbital overlaps with an sp^2 orbital from the other carbon to form a carbon-carbon sigma bond.

The non-bonding *2p* orbitals overlap side-by-side to form a carbon-carbon pi bond.



C_2H_4





A.O.

$s + p_x + p_z \longrightarrow sp^2 + sp^2 + sp^2$

3σ

$p_y \longrightarrow p_y$

π (leftover p)