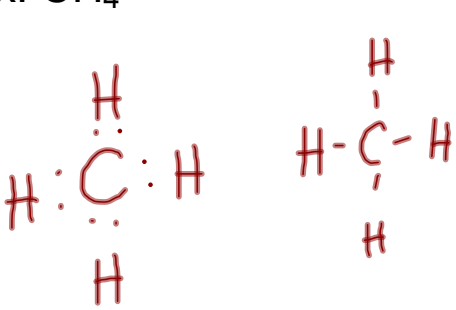
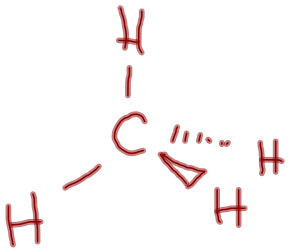
VSEPR Theory

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

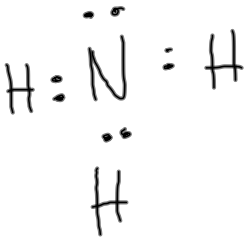


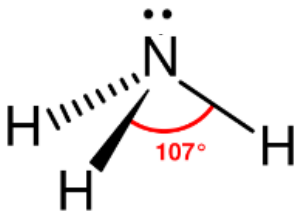


tetrahedral angle (109.5°)

Ex. NH_3

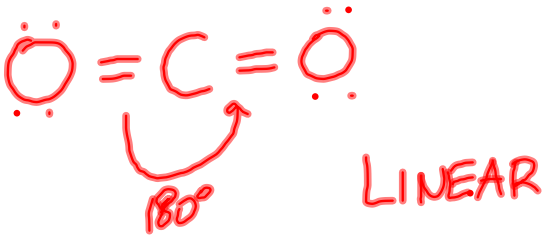
Lone pairs (unshared pairs) also affect the shapes of molecules.



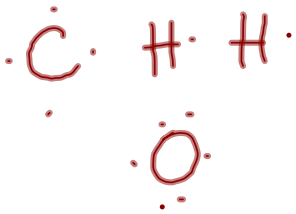


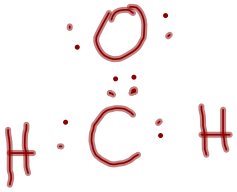
Ex. CO_2

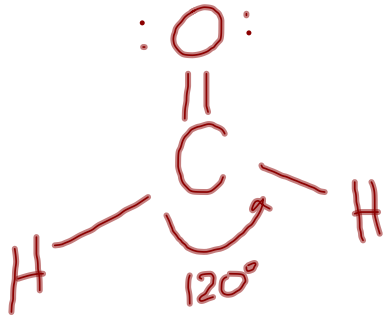
When predicting molecular shapes, double and triple bonds are treated as single bonds.

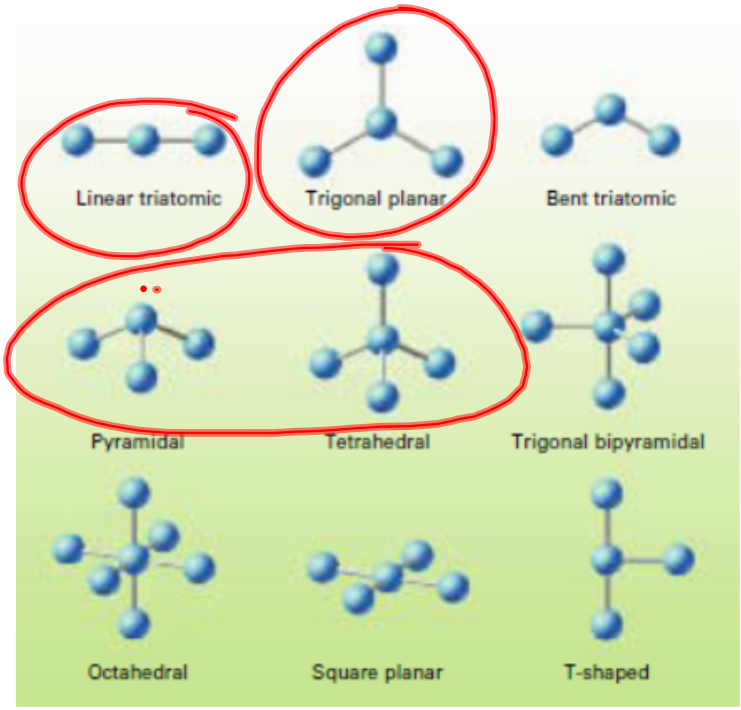


Ex. CH_2O







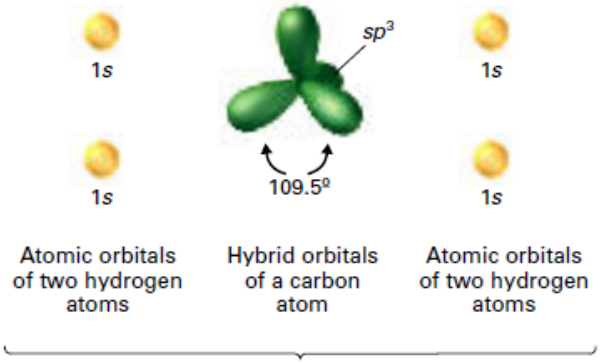

Linear triatomic
Trigonal planar
Bent triatomic
Pyramidal
Tetrahedral
Trigonal bipyramidal
Octahedral
Square planar
T-shaped

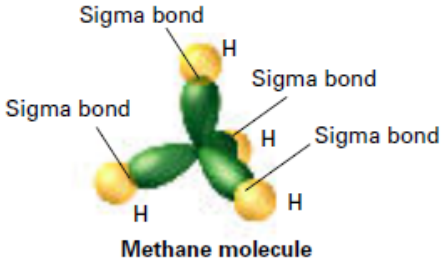
Hybridization Involving Single Bonds

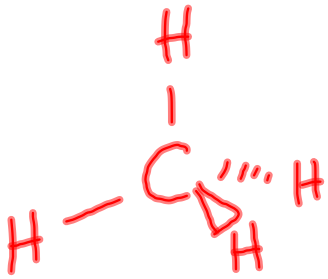
In **hybridization**, atomic orbitals mix to form the same total number of equivalent hybrid orbitals.

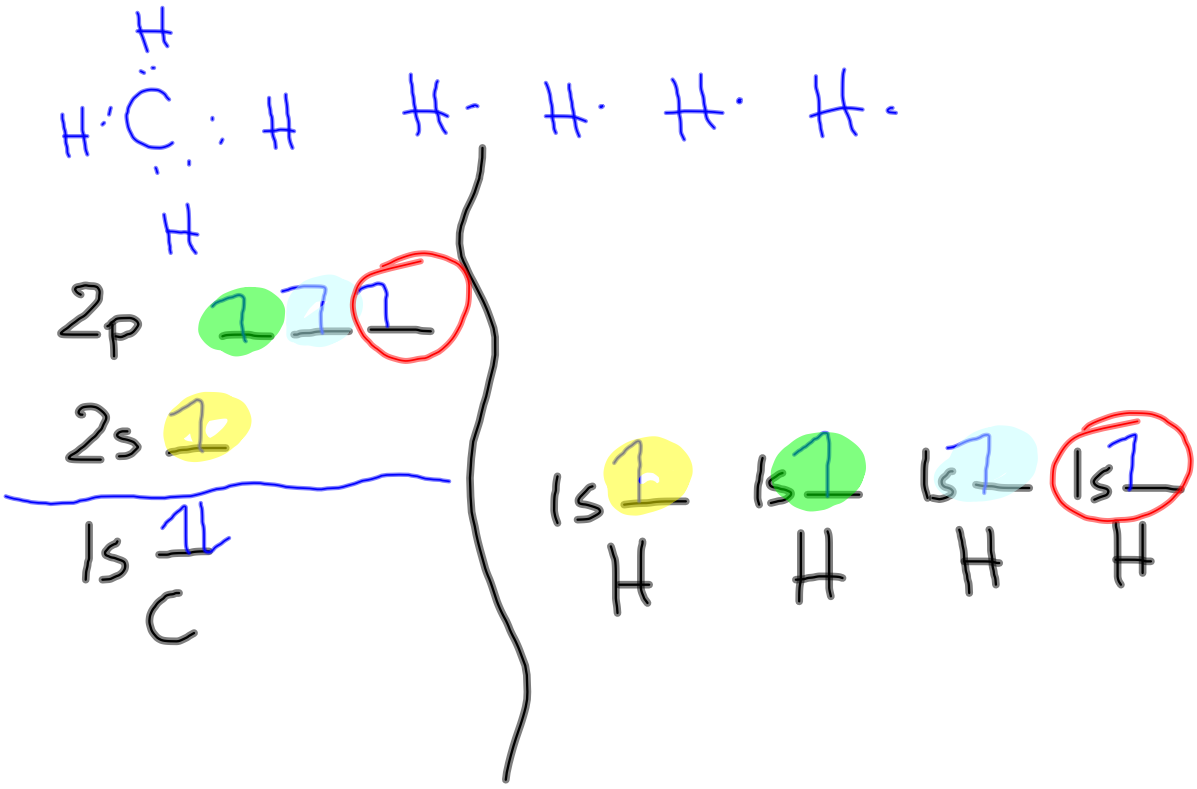
Ex. CH_4

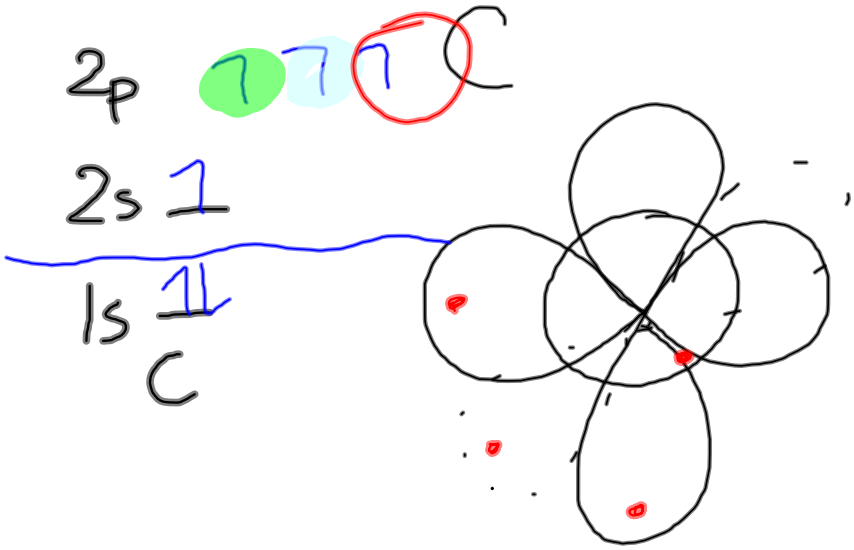
The one *2s* orbital and three *2p* orbitals of a carbon atom mix to form four sp^3 hybrid orbitals.








2p
2s
1s
C
1s
H
1s
H
1s
H
1s
H

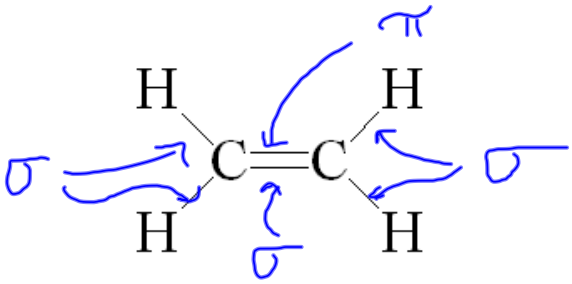


$$S + p_x + p_y + p_z \longrightarrow$$

$$sp^3 + sp^3 + sp^3 + sp^3$$

Hybridization Involving Double Bonds

Ex. C_2H_4

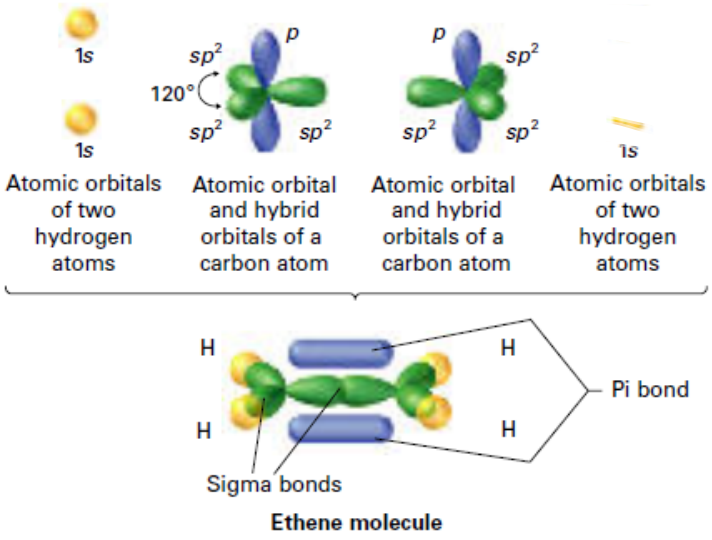


The one *2s* orbital and two *2p* orbitals of each carbon atom mix to form three sp^2 hybrid orbitals.

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.



$$S + p_x + p_y \longrightarrow sp^2 + sp^2 + sp^2$$

σ σ σ

p_z π

↑ leftover p orbital makes pi bond.

Hybridization Involving Triple Bonds

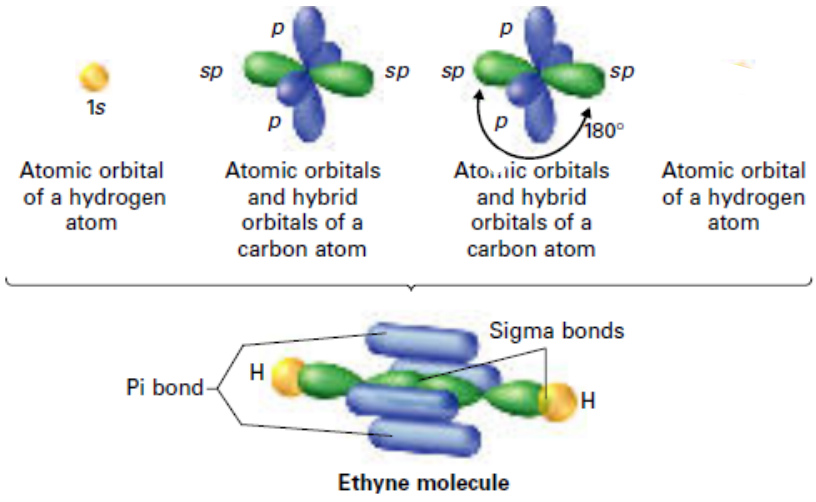
Ex. C_2H_2

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

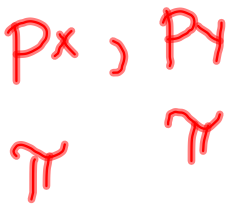
One of the *sp* orbitals overlap with the *1s* hydrogen orbital to form carbon-hydrogen sigma bonds.

The second *sp* orbital overlaps with the *sp* orbital from the other carbon to form a carbon-carbon sigma bond.

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




s + pz
Sp + Sp
σ σ


px , py
π π

http://www.mhhe.com/physsci/chemistry/animations/chang_7e_esp/bom5s2_6.swf