ORGANIC CHEMISTRY 1 LECTURE GUIDE 2019

BY RHETT C. SMITH

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Organic Chemistry 1
Lecture Guide 2019

By Rhett C. Smith, Ph.D.

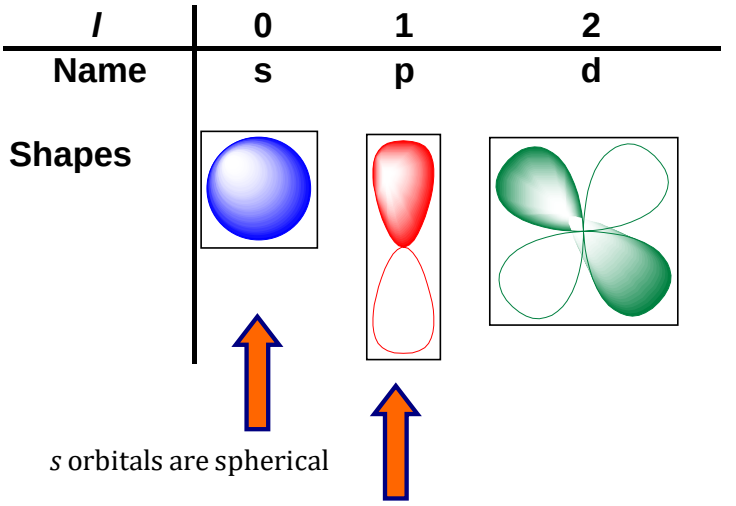
Companion Books from the Proton Guru:

Organic Chemistry 1 Reactions and Practice Problems 2019

by Rhett C. Smith

Organic Chemistry 1 Primer 2019,

by Rhett C. Smith, Andrew G. Tennyson, and Tania Houjeiry



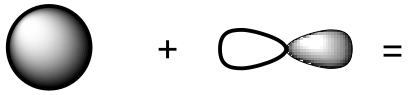
s orbitals are spherical

p orbitals are hourglass-shaped
There are three *p* orbitals in each shell;
One on each of the axes (x, y, and z)

Notes

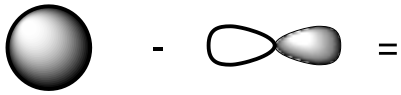
Two Orbitals can combine ...

... by adding ...



s orbital *p* orbital

... or by subtracting ...



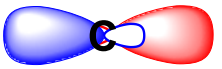
s orbital *p* orbital

... to form **two** new orbitals.

Adding or "hybridizing" one *s* orbital with one *p* orbital gives two hybrid orbitals.

Notes

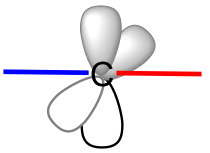
Drawing both sp hybrid orbitals on the same atom:



This is an _____ carbon atom.

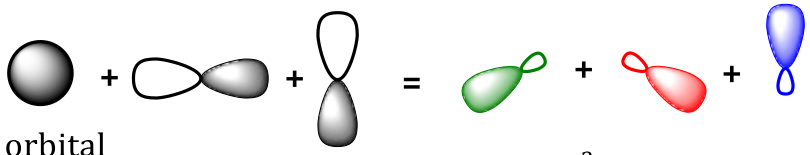
The *sp* orbitals are pointed directionally _____

from one another, resulting in a _____ geometry.



Since carbon has three *p* orbitals and we only used one to make the hybrids, two *p* orbital are still left unhybridized on carbon:

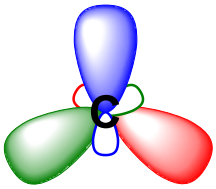
Notes



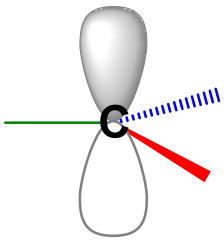
s orbital

three ***sp*^{2} hybrid orbitals.**

Drawing all three sp^2 hybrid orbitals on the same atom:

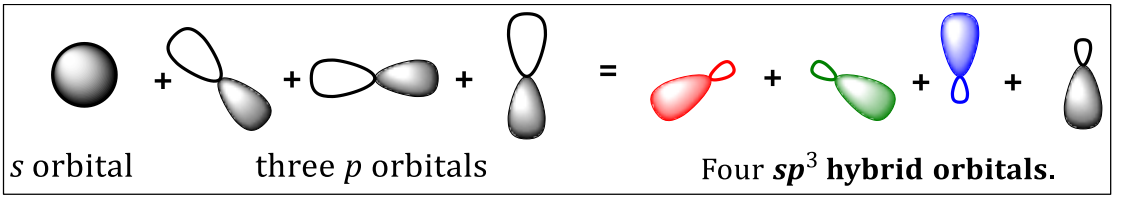


This is an **sp^2 hybridized** carbon atom. The *sp*^{2} orbitals are in a plane pointed directionally _____ from one another, towards the corners of an equilateral triangle in a _____ geometry.

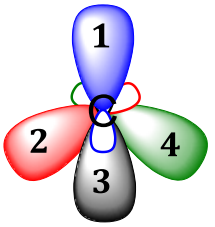


Since carbon has three *p* orbitals and we only used two to make the hybrids, a p orbital is still left unhybridized on carbon.

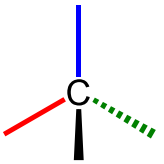
Notes



Drawing all four sp^3 hybrid orbitals on the same atom:



This is an sp^3 hybridized carbon atom. The sp^3 orbitals are pointed directionally _____ from one another, in a _____ geometry.



Since carbon has three p orbitals and we used all three to make the hybrids, all of the valence orbitals are now sp^3 orbitals, and consequently these are the only ones used in bonding.

Notes

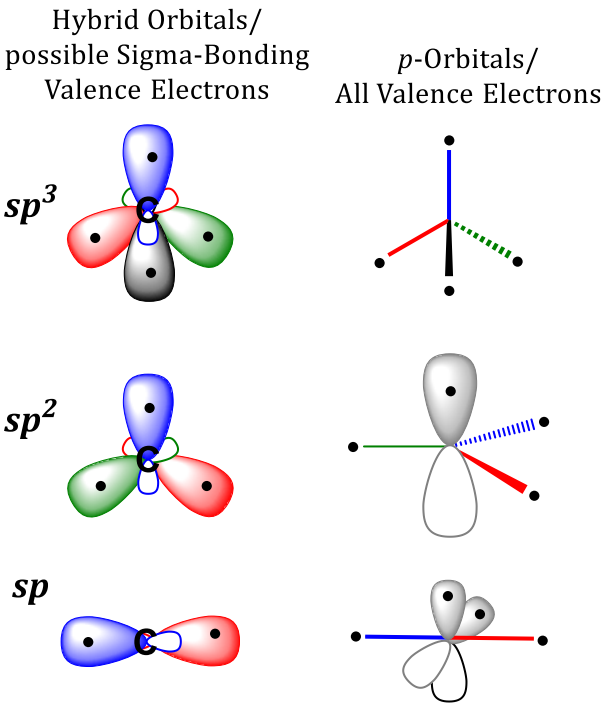
Sigma (σ) and Pi (π) Bonds

A sigma (σ) bond is one in which the electrons making the bond are between the two nuclei joined by the bond:

A pi (π) bond is one in which the electrons lie above and below the line between the two nuclei which are joined by the bond:

In the vast majority of examples in introductory organic, the **hybrid orbitals** will form sigma bonds or will be filled by a lone pair of electrons, and any pi bonds will be made by p orbitals not hybridized into sp, sp^2, or sp^3 orbitals…

Notes


Hybrid Orbitals/
possible Sigma-Bonding
Valence Electrons
p-Orbitals/
All Valence Electrons
sp3
sp2
sp

Notes

We can bind two sp^3 hybridized carbons together and make sigma bonds to hydrogen atoms with the remaining sp^3 orbitals

This is ETHANE. There are no more valence orbitals, so we can make no more bonds.

Notes

In Ethylene, the sp^2 hybrid orbitals form sigma bonds with C and H.

We have a pi orbital left over on each carbon, each with one electron. These two orbitals overlap to form a pi bond, so ethylene's line-bond structure is:

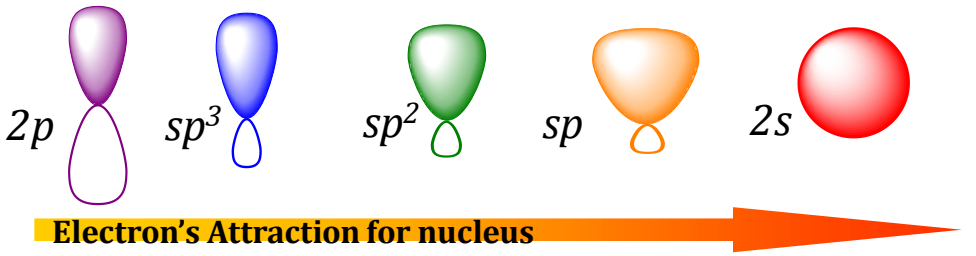
Notes

In acetylene, the *sp*-hybrid orbitals are again used to make the sigma bonds.

Each of the two *sp*-hybridized carbon atoms has two *p* orbitals left unhybridized, so there will be two pi bonds formed between the carbon atoms, yielding acetylene's line-bond structure:

Notes

Electronegativity is how strongly an atom holds its electrons in a bond. How strongly electrons are held depends on the orbital that holds the electrons:



An orbital that has more **A** has a greater pull on electrons.

So, the electronegativity trend is:

B

An *sp* hybridized C atom has about the **same electronegativity** as an sp^3-hybridized N atom

Notes