Bonding, Shape, and Polarity

UCI Chem 51A

Dr. Link

Oops!

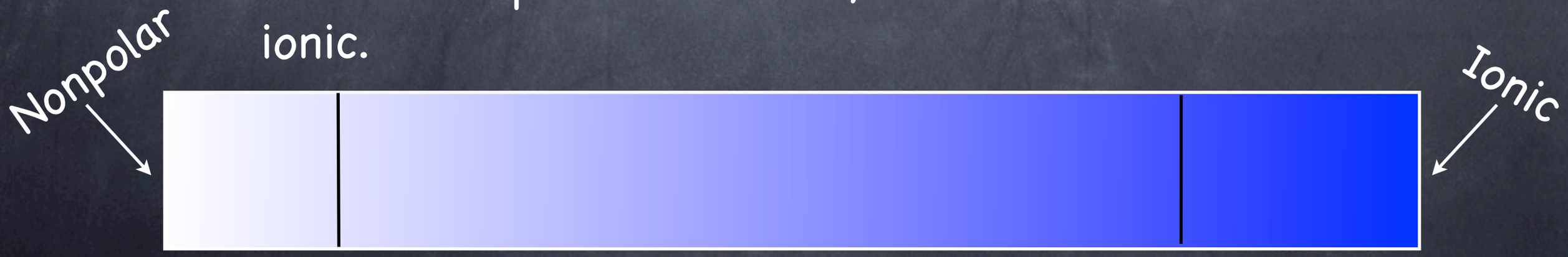
- There are two mistakes in the vocal narration (bonding section). Can you find them?

Goals

- After this lesson you should be able to:
  - Predict geometries around atoms in a molecule.
  - Predict polarity based on bonding and shape.
  - Identify types of bonds in a molecule.
  - Identify types of orbitals used to make bonds.

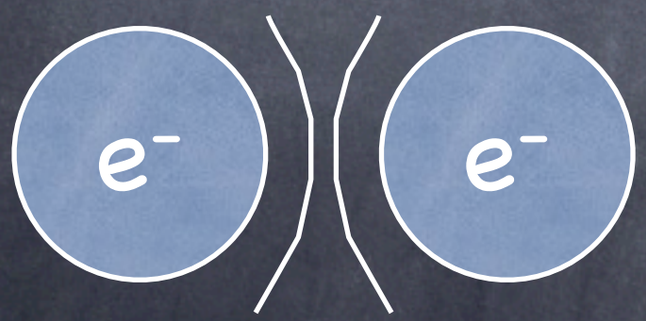
Bonding Review

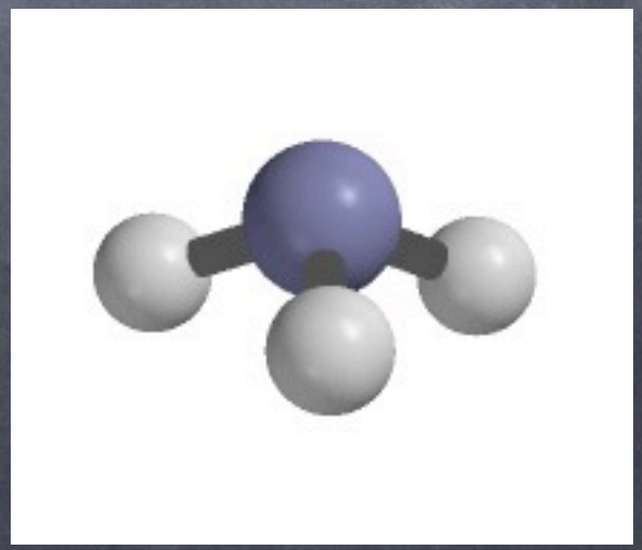
- In organic chemistry we generally deal with covalent bonds (both polar and nonpolar), though ionic compounds show up sometimes.
- Covalent bonds: Atoms are sharing one or more pairs of electrons
- Polar covalent bonds: For our purposes, an electronegativity difference of 0.4 or less can be considered nonpolar. Differences up to 1.8 are considered polar. Above 1.8, bonds are considered ionic.



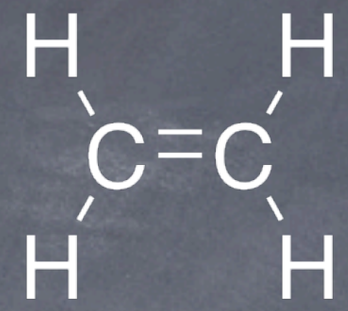
VSEPR Review

- Valence Shell Electron Pair Repulsion: Regions of electron density around atoms repel each other and determine geometry around that atom.





VSEPR Table



e- density regions	Bonded atoms	e- geometry	Geometry	Bond Angles
2	2	planar	planar	180°
3	2	trigonal planar	bent	120°
3	3	trigonal planar	trigonal planar	120°
4	2	tetrahedral	bent	109.5°
4	3	tetrahedral	trigonal pyramidal	109.5°
4	4	tetrahedral	tetrahedral	109.5°

Geometry Examples

C_2H_2 BF_3 CH_4

NH_3 H_2O

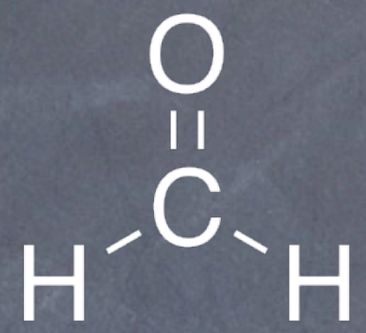
Drawing Tetrahedral Structures: Wedges and Dashes

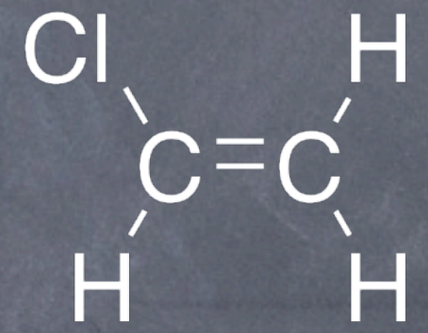
- Tetrahedral structures have two bonded groups in one plane and two in another.
- How can we represent this in drawings?
- Wedge: Coming forward out of board/ paper/screen
- Dash: Going back behind board/paper/ screen

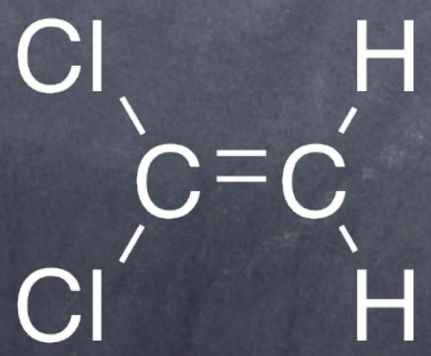
Shape and Polarity

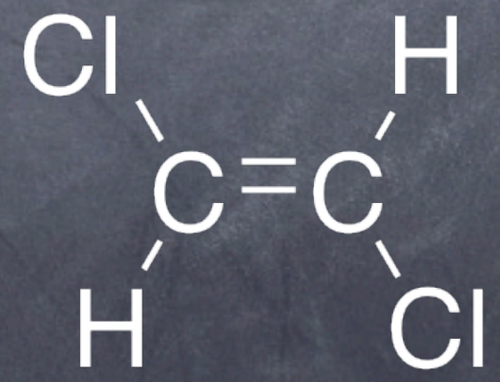
- How can we predict a molecule's polarity?
  - To be polar:
    - 1. A molecule must have at least one polar bond (dipole moment).
    - 2. The dipole moments must not cancel out.

Polar or Nonpolar?







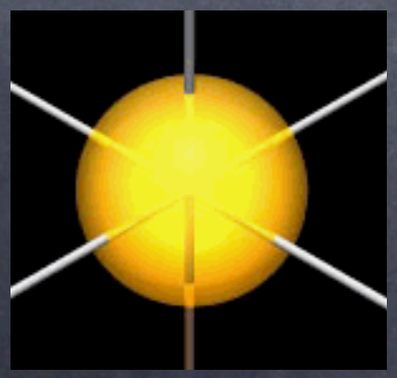


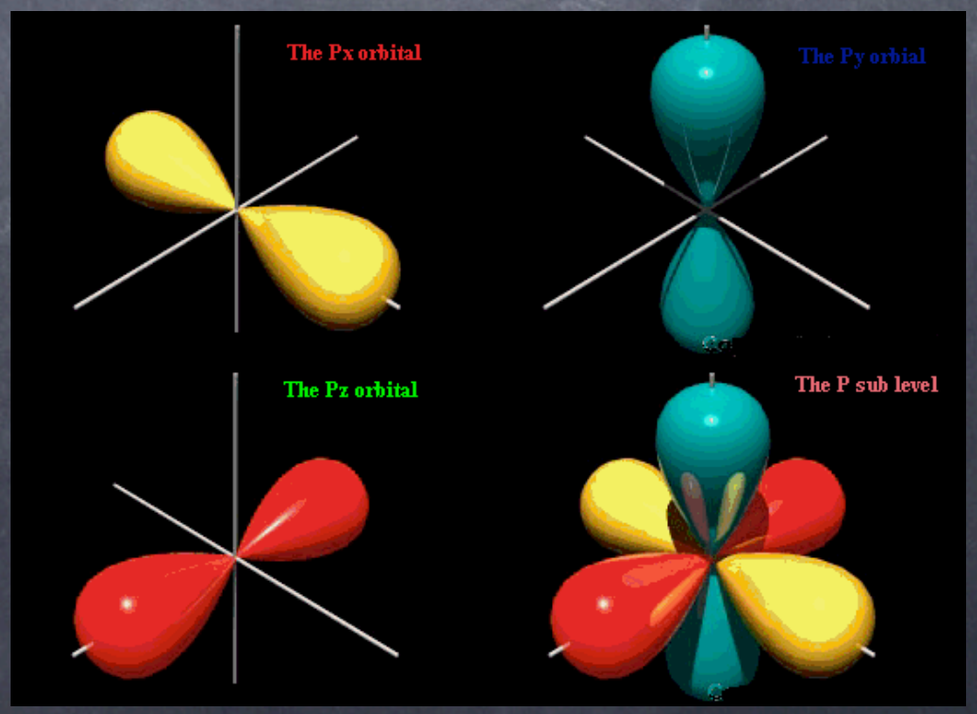
Why Is Polarity of Molecules Important?

- Molecule polarity determines intermolecular forces!
- Intermolecular forces determine physical properties!

Common Types of Bonds in OChem

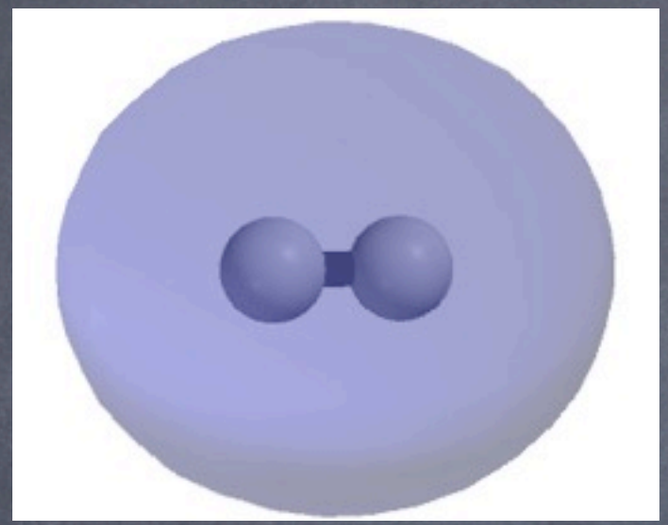
- Sigma bonds: Formed by direct overlap of two orbitals. Can be s-s, s-p, s-hybrid, hybrid-hybrid
- Pi bonds: Formed by indirect (sideways) overlap of two orbitals. Usually p-orbitals.
- Atomic orbital shapes:



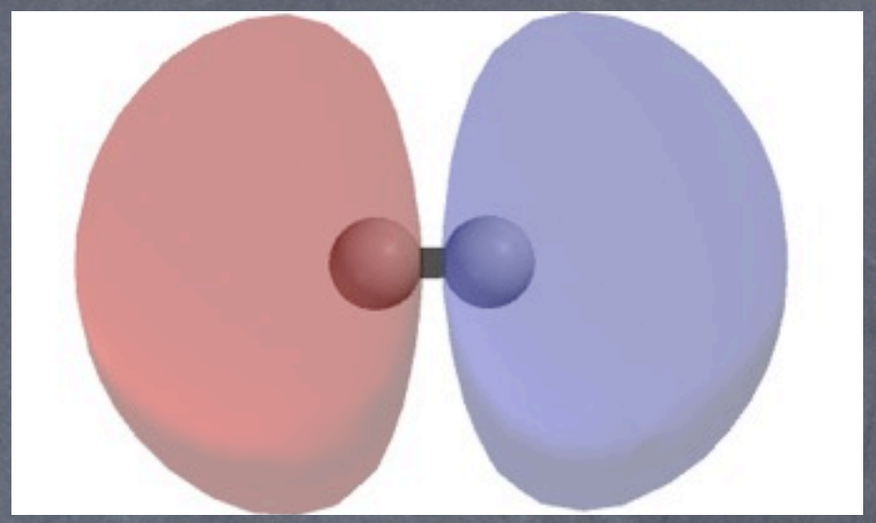


Bond Examples

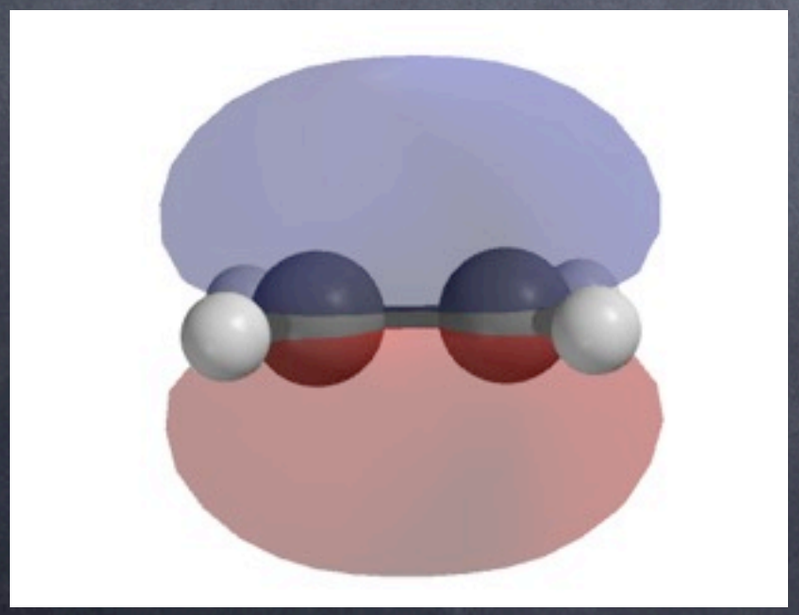
σ



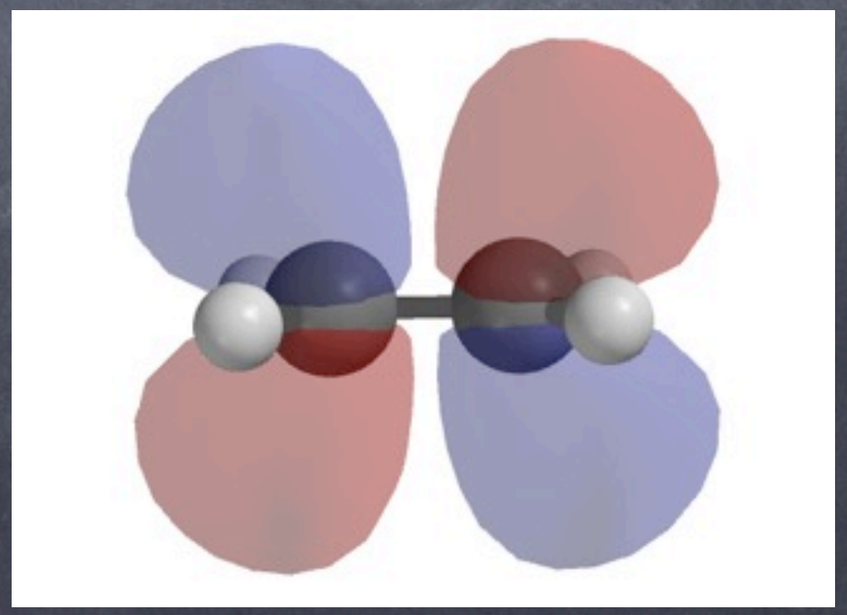
σ*



π



π*



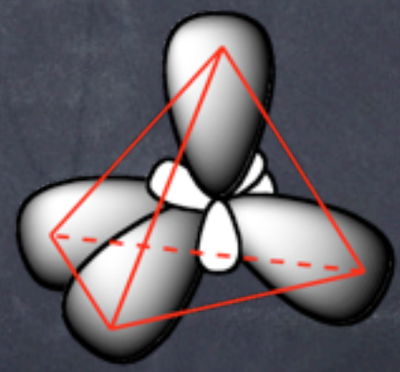
Bonding and Hybrid Orbitals

- We often use hybrid orbitals to describe bonding.
- Quick review of hybrid orbitals.
  - # of orbitals in = # of orbitals out

Hybrid Orbitals

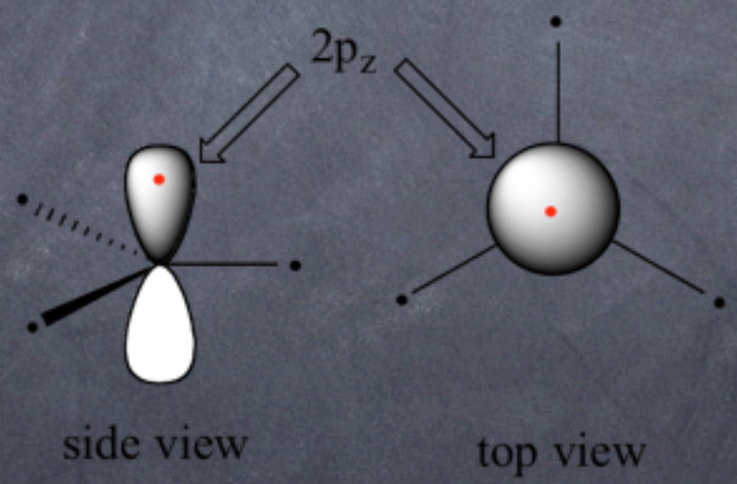
1 *s*-orbital
3 *p*-orbitals

4 sp^3 orbitals



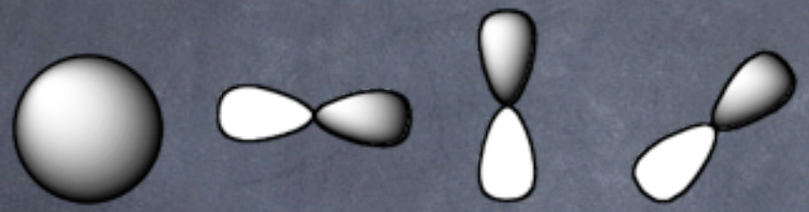
Hybrid Orbitals and Double Bonds

3 sp^2 p

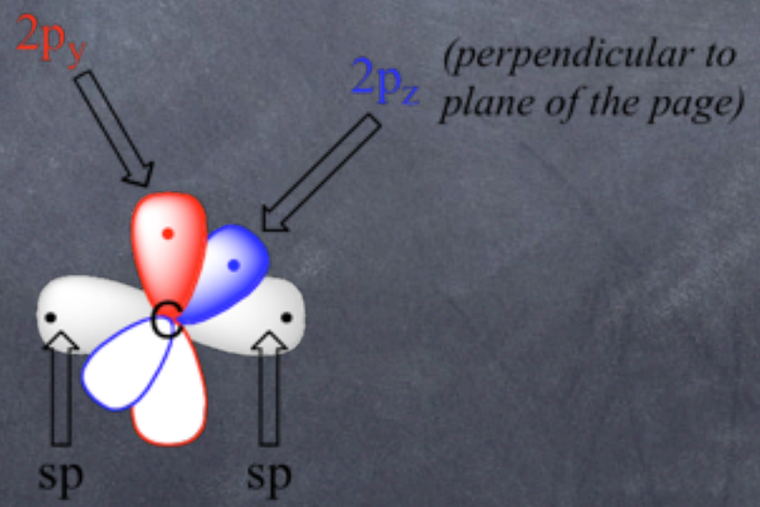


trigonal planar

Hybrid Orbitals and Triple Bonds

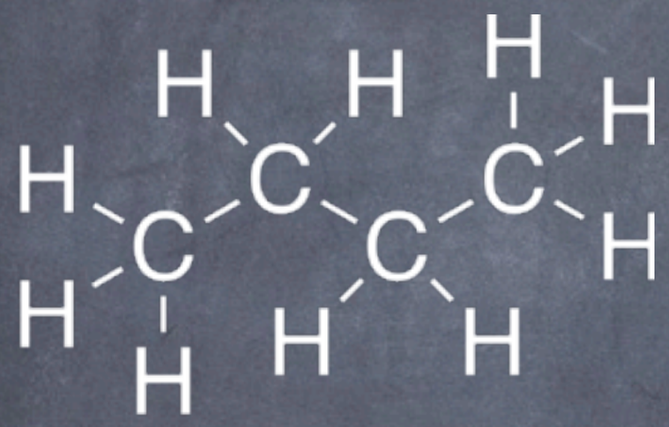


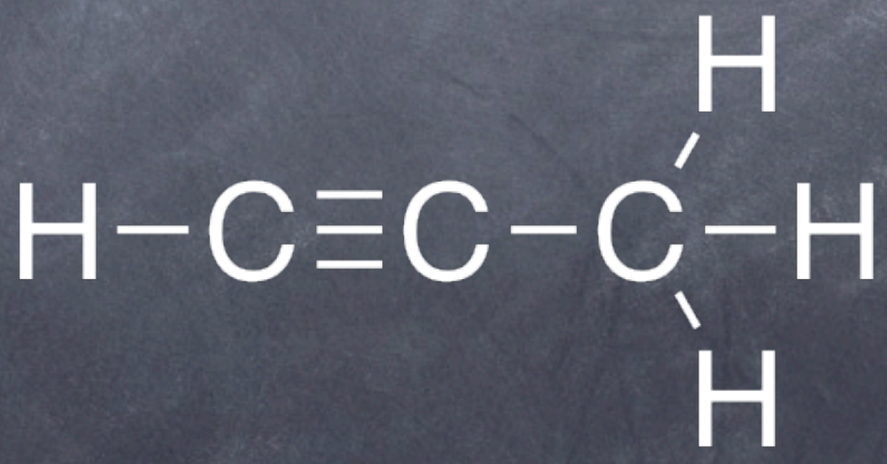
2 sp 2 p orbitals



linear

Identifying Shape, Bonding, and Hybrid Orbitals





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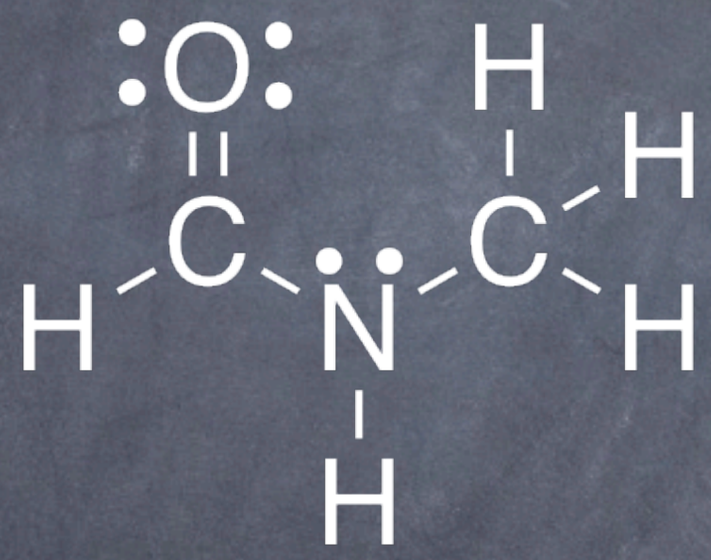

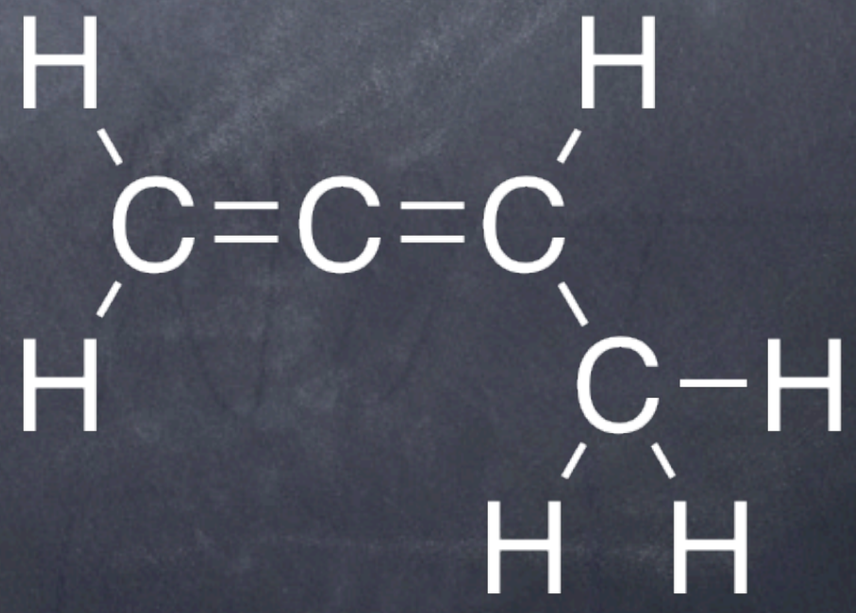

Wrapping Up

- Practice determining geometries around atoms in Lewis structures.
- Practice determining whether a molecule is polar.
- Practice identifying types of bonds and from which types of orbitals the bonds are formed.