

Bonding, Shape, and Polarity

UCI Chem 51A

Dr. Link

Oops!

- ④ There are two mistakes in the vocal narration (bonding section). Can you find them?

Goals

- ④ After this lesson you should be able to:
 - ④ Predict geometries around atoms in a molecule.
 - ④ Predict polarity based on bonding and shape.
 - ④ Identify types of bonds in a molecule.
 - ④ 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.

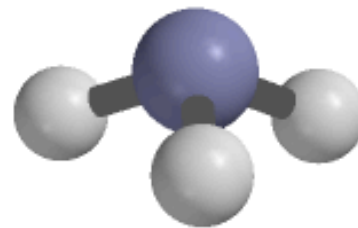
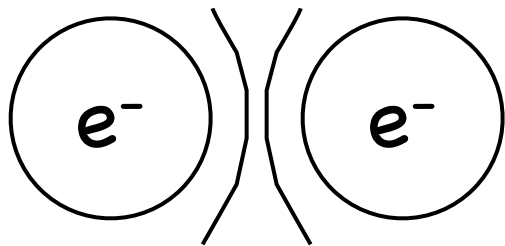
Nonpolar



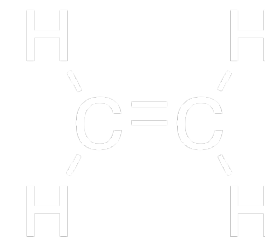
Ionic

VSEPR Review

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

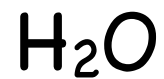
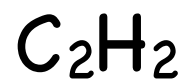


VSEPR Table



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



Drawing Tetrahedral Structures: Wedges and Dashes

- ④ Tetrahedral structures have two bonded groups in one plane and two in another.
- ④ How can we represent this in drawings?
 - ④ Wedge: Coming forward out of board/paper/screen
 - ④ Dash: Going back behind board/paper/screen

Shape and Polarity

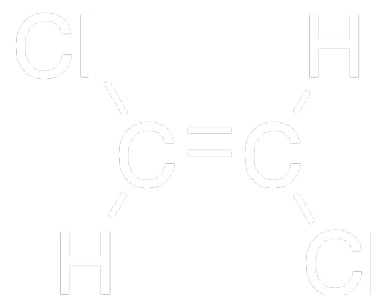
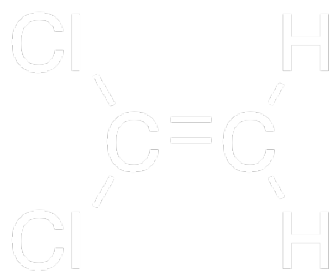
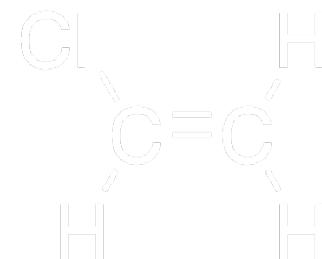
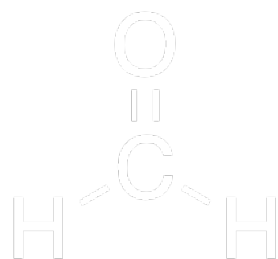
③ How can we predict a molecule's polarity?

③ To be polar:

③ 1. A molecule must have at least one polar bond (dipole moment).

③ 2. The dipole moments must not cancel out.

Polar or Nonpolar?



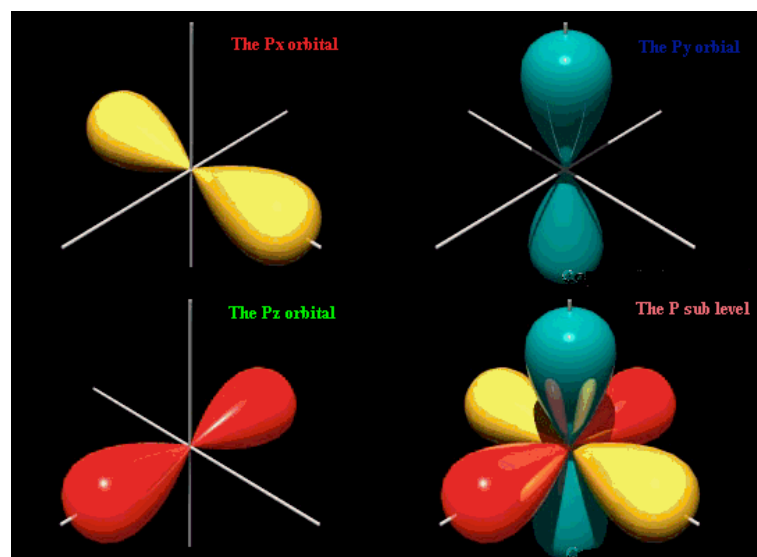
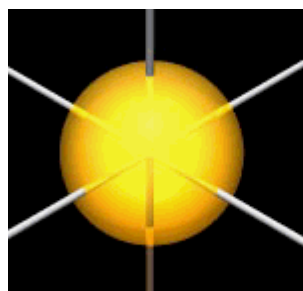
Why Is Polarity of Molecules Important?

- ④ Molecule polarity determines intermolecular forces!
- ④ Intermolecular forces determine physical properties!

Common Types of Bonds in OChem

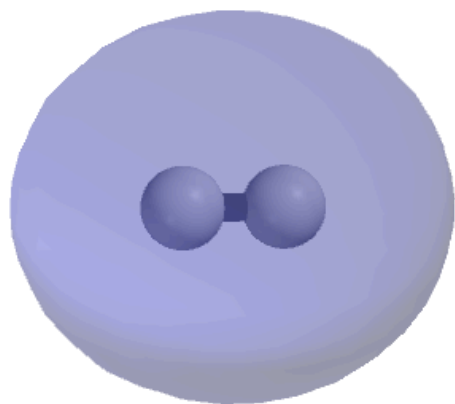
- ❖ Sigma bonds: Formed by direct overlap of two orbitals. Can be s-s, s-p, s-hybrid, hybrid-hybrid
- ❖ Pi bonds: Formed by indirect (sideways) overlap of two orbitals. Usually p-orbitals.

❖ Atomic orbital shapes:

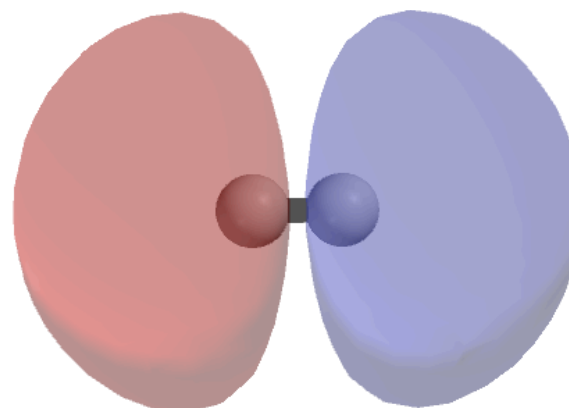


Bond Examples

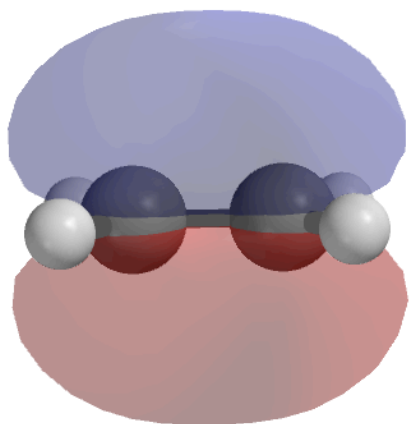
σ



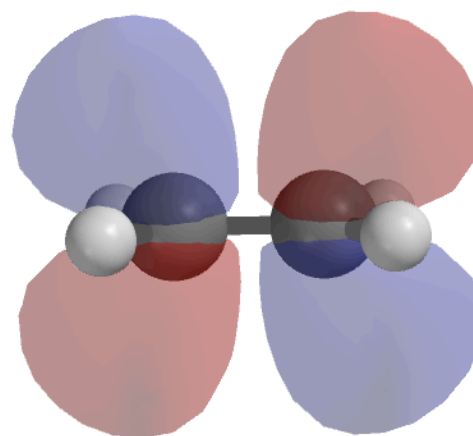
σ^*



π



π^*



Bonding and Hybrid Orbitals

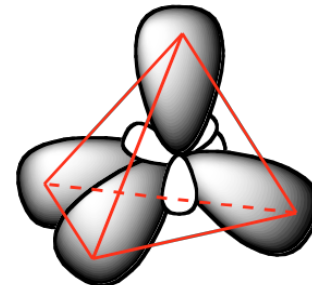
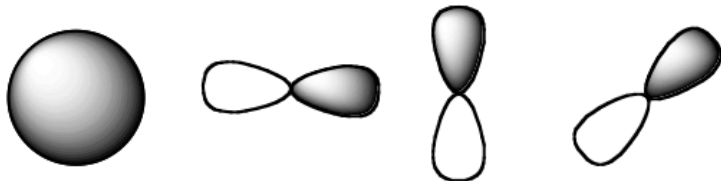
- ④ We often use hybrid orbitals to describe bonding.
- ④ Quick review of hybrid orbitals.
 - ④ # of orbitals in = # of orbitals out

Hybrid Orbitals

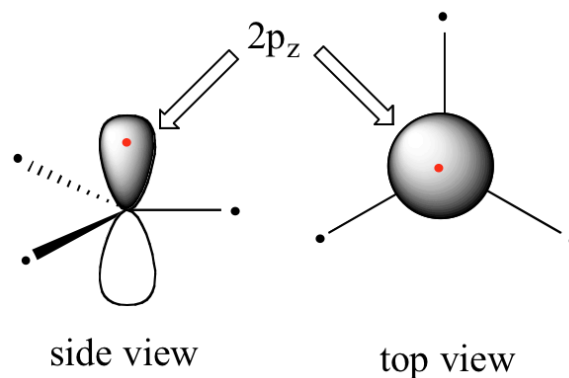
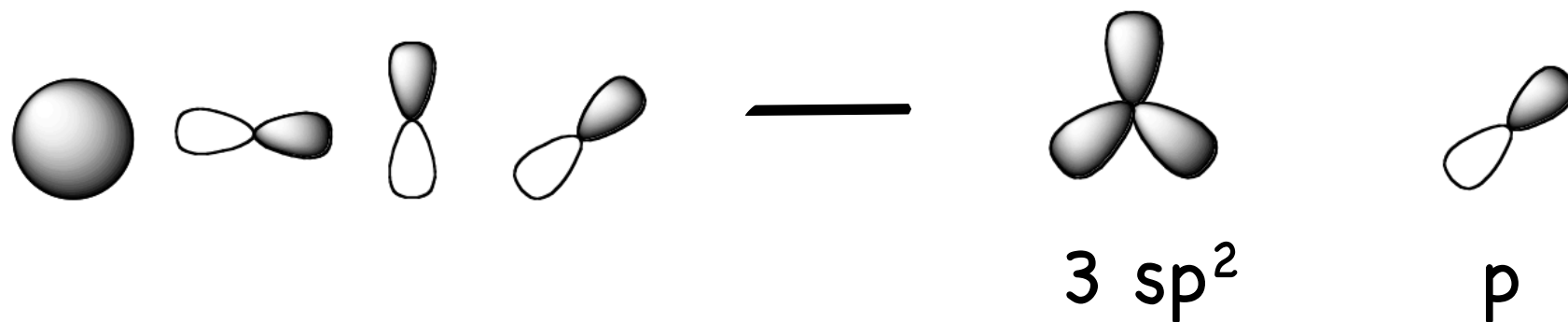
1 *s*-orbital
3 *p*-orbitals



4 *sp*³ orbitals

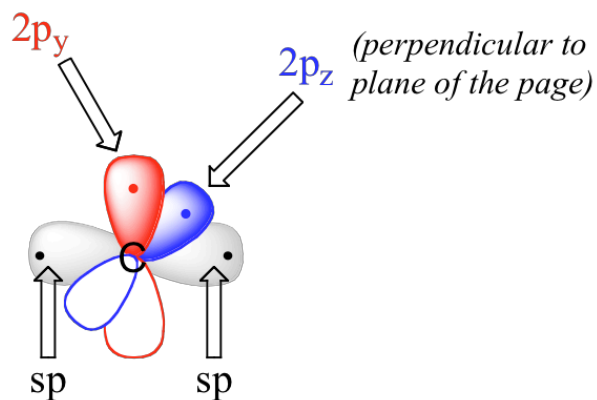
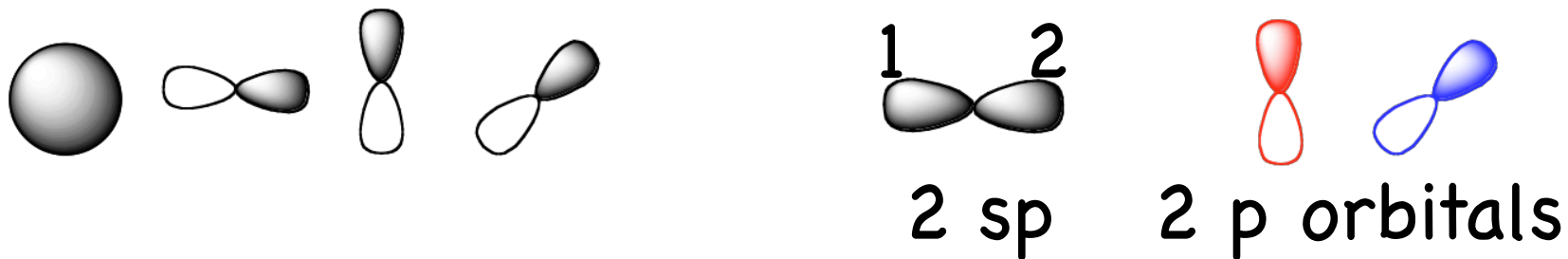


Hybrid Orbitals and Double Bonds



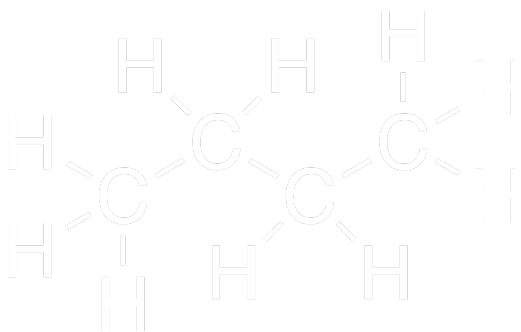
trigonal planar

Hybrid Orbitals and Triple Bonds

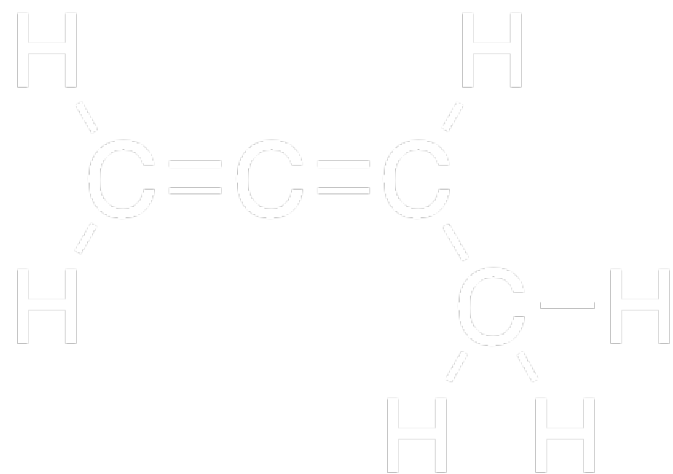
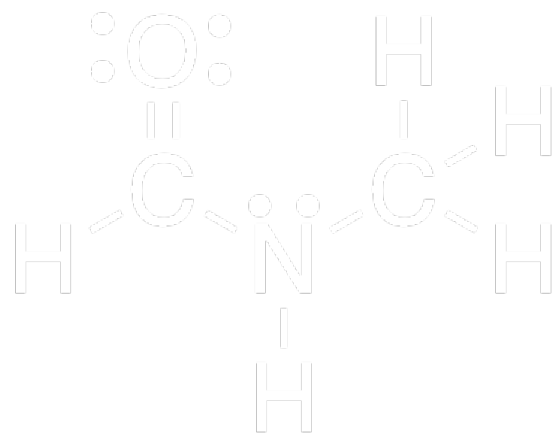


linear

Identifying Shape, Bonding, and Hybrid Orbitals



Identifying Shape, Bonding, and Hybrid Orbitals



Wrapping Up

- ③ Practice determining geometries around atoms in Lewis structures.
- ③ Practice determining whether a molecule is polar.
- ③ Practice identifying types of bonds and from which types of orbitals the bonds are formed.