Today

Sections 1.7-1.15
An Introduction to Valence Bond Theory

Sections 2.1 and 2.3
Acids and Bases

Next Class

Sections 2.6 - 2.9
How structure affects acidity and basicity

hybrid orbitals are used to form σ bonds and to hold lone-pair electrons

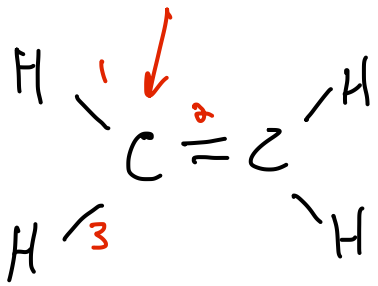
single bonds are always σ bonds

double and triple bonds are formed from σ bonds and π bonds

# of σ bonds + pairs of lone-pair electrons = # of hybrid orbitals needed

count out the # of atomic orbitals need to make the hybrid orbitals
starting with the 2s orbital (or 3s if appropriate)

name the hybrid orbitals sp^n where n is the number of p orbitals used

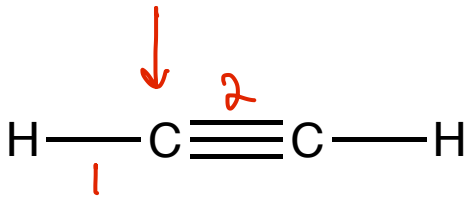


3 σ bonds 3 HO's

2s 2p$_x$ 2p$_y$ ⇒ sp^2 hybridized C atom

https://www.westfield.ma.edu/PersonalPages/cmasi/organic/hybrid/hybrid.html

Identify atoms that use sp^3 hybrid orbitals to form bonds and hold lone-pair electrons

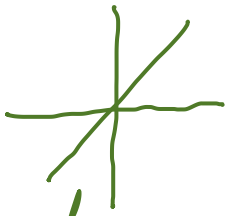


2 σ bonds means 2 HO's needed

2s + $2p_z$ ⟹ sp hybridized C atom

an unhybridized p orbital on each atom overlap to form a π bond

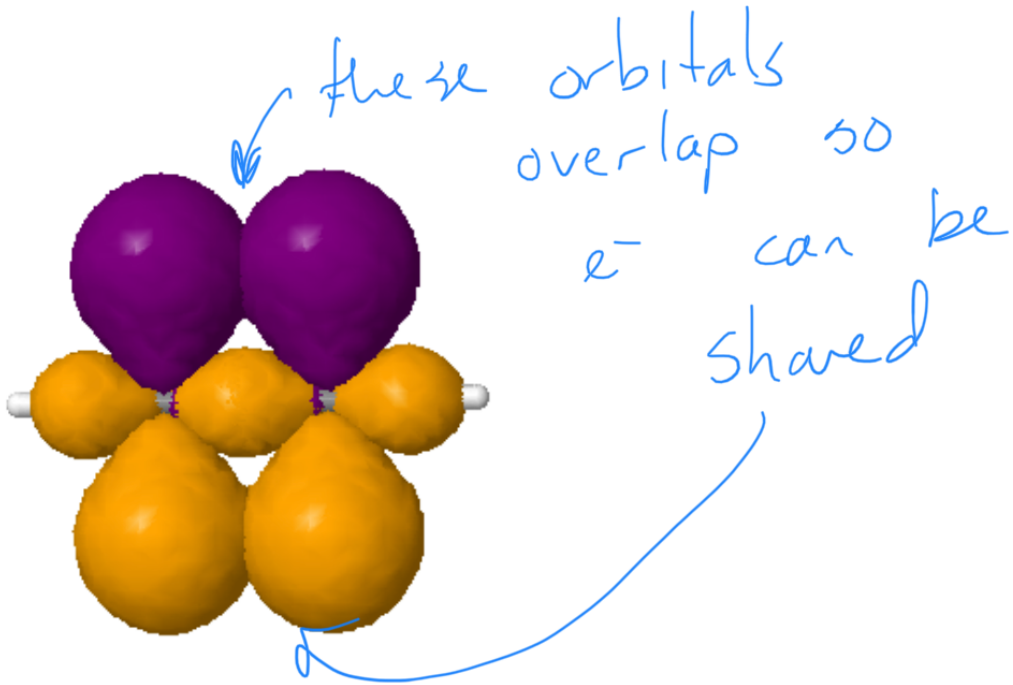
the other unhybridized p orbital on each C atom over laps to form a second π bond



σ bond + π bond + π bond = triple bond

https://www.westfield.ma.edu/PersonalPages/cmasi/organic/hybrid/hybrid2.html

Identify atoms that use sp hybrid orbitals to form bonds and hold lone-pair electrons



JSmol

C sp AO s | C sp AO s

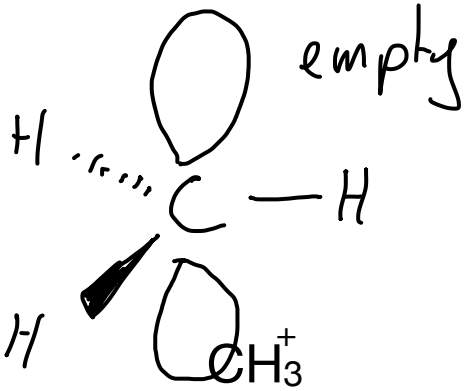
H S AO | H S AO

C px AO | C py AO

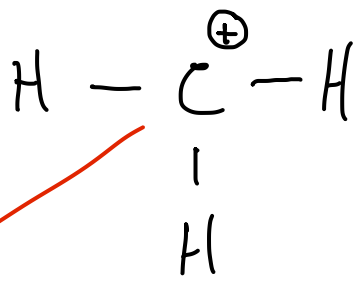
remove AO(s)

remove AO(s)

The methyl cation, anion, and radical



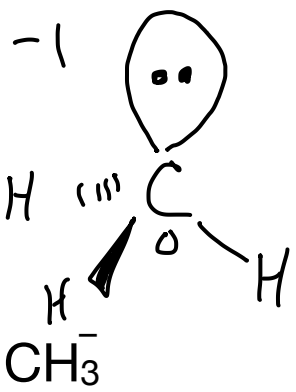
3 σ bonds
3 HO's needed



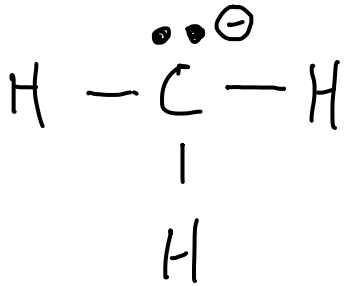
$2s \times 2p_x \times 2p_y \rightarrow sp^2$

this atom has an empty $2p_z$ orbital

FC = 4 − (2 + 3)
= −1



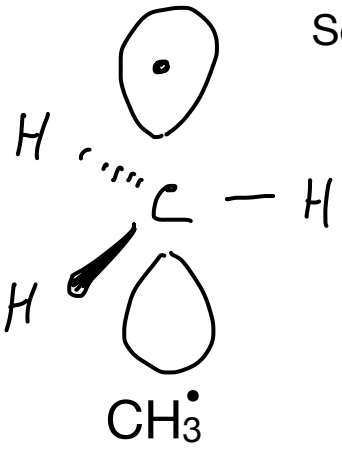
3 σ bonds
1 lp e^-



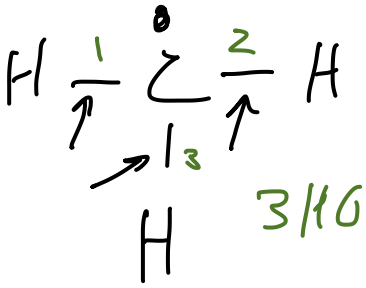
4 HO's

$2s \times 2p_x \times 2p_y \times 2p_z$

sp^3



3 σ bonds
no lp e^-'s



3 HO's needed

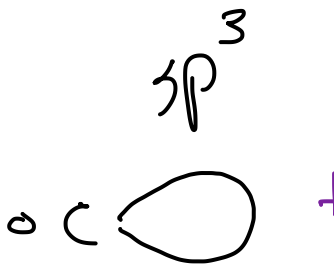
$2s \times 2p_x \times 2p_y \Rightarrow sp^2$

$1e^-$ not enough to repell pairs

• means radical

radicals are odd e^- species

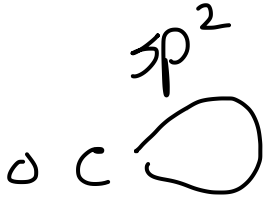
Determine the hybridization of unusual molecular fragments



25% s 75% p

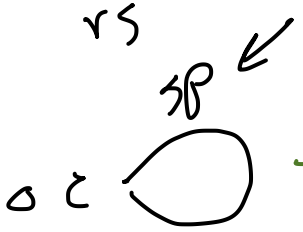
the e⁻'s in sp^3 orbitals are highest in E

vs



33% s 67% p

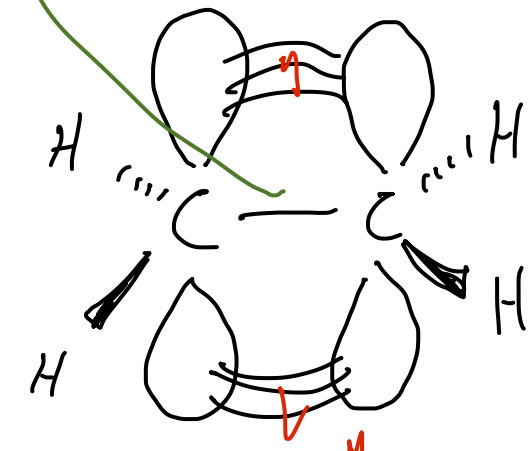
vs



this orbital is 50% s + 50% p

the e⁻'s in sp orbitals are lowest in E

e⁻'s stuffed down between the nuclei



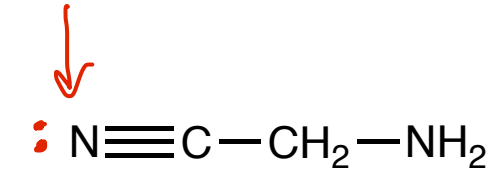
out away from nuclei

$CH_2 = CH_2$

Explain observations and make predictions based on the hybridization of an atom

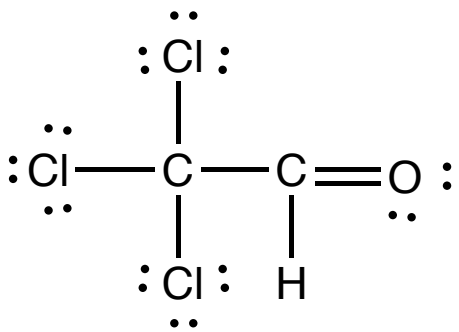
s orbitals get e⁻'s closer to nucleus, so e⁻ is lower in E

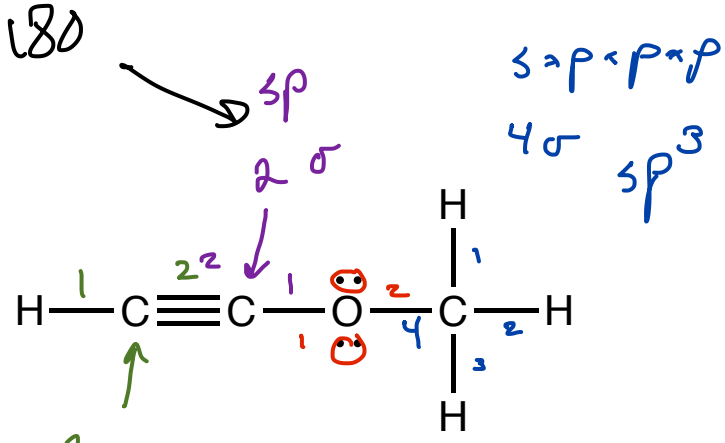
Practice



σ + lp e⁻

sp





180

sp

2 σ

2 σ

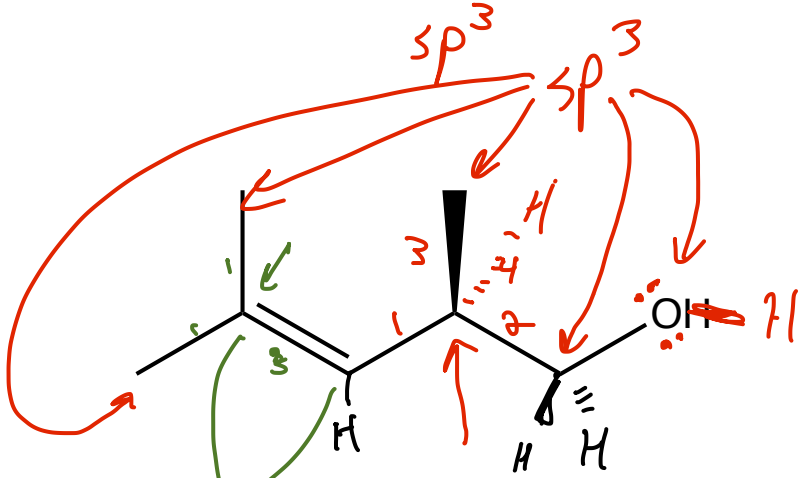
sp

2σ

2 lp e⁻

s > p < p = p

4σ sp³

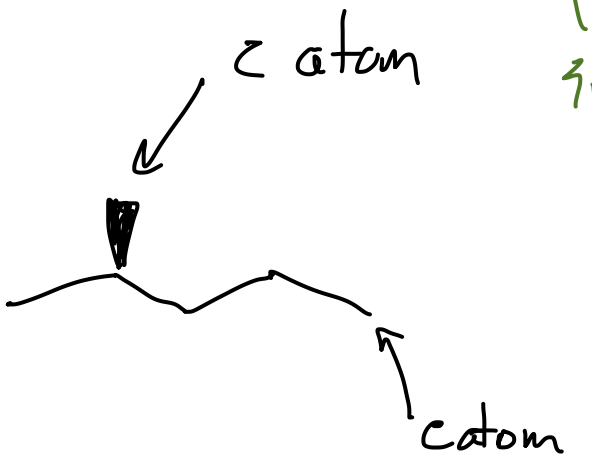


sp³ sp³

sp²

4σ bonds

sp³



C atom

C atom

pK_a is *backwards*