Today

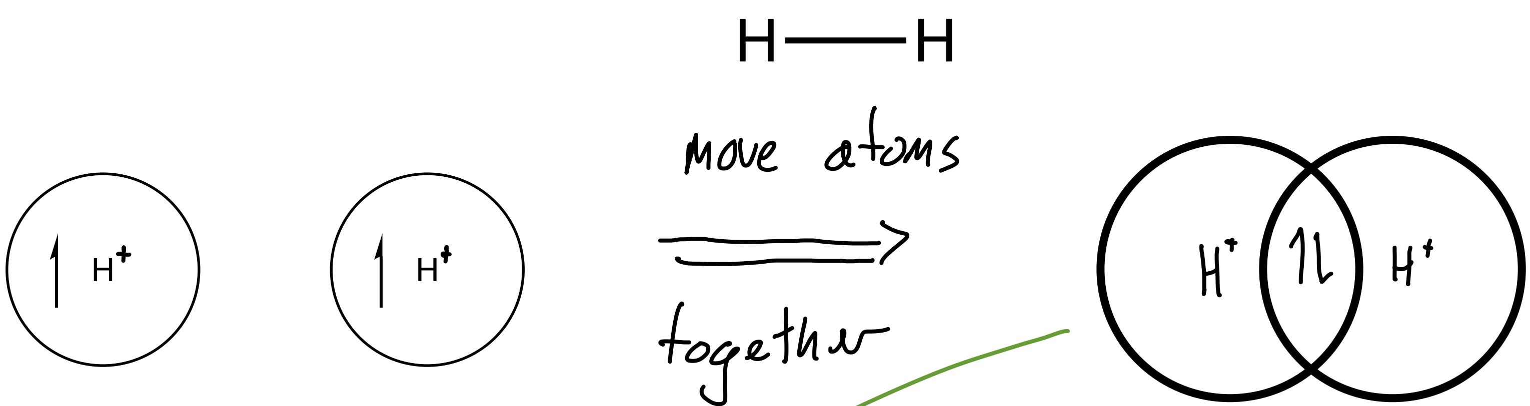
Sections 1.7-1.15
An Introduction to Valence Bond Theory

Next Class

Sections 2.1, 2.11, and 2.10
Acids and Bases

Sections 2.6 - 2.9
How structure affects acidity and basicity

Survey Monkey link emailed this morning. Please indicate whether you plan on taking Organic II

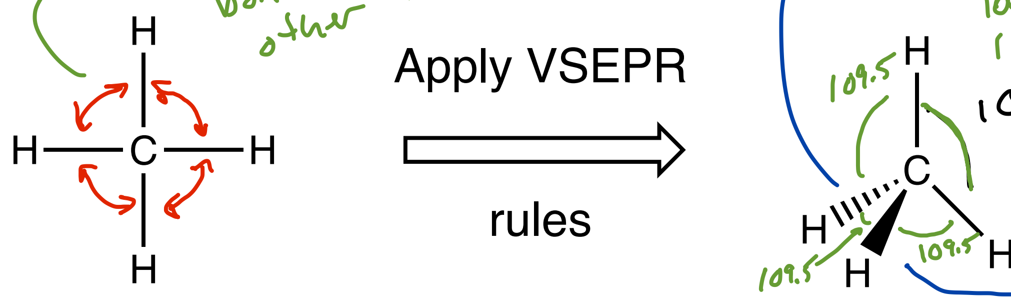


Singly occupied AO's can overlap and share e⁻'s

because the H nuclei are attracted to the same e⁻'s, they are stuck together.

They have a mutual attraction for a pair of shared e⁻'s; they are bonded together.

e⁻ pairs in bonds repel each other

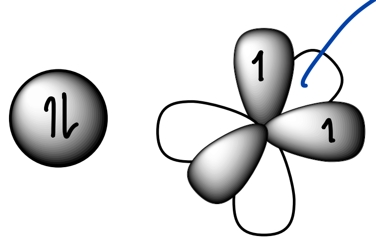


behind screen

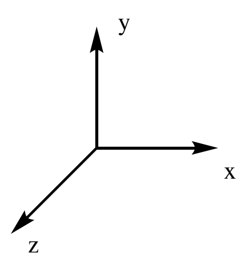
largest bond angle possible

in front of screen

tetrahedral C atom



$2s^2$ $2p_x^1$, $2p_y^1$, $2p_z$



90° ∡ between orbitals not 109.5° ∡ that is seen between C-H bonds

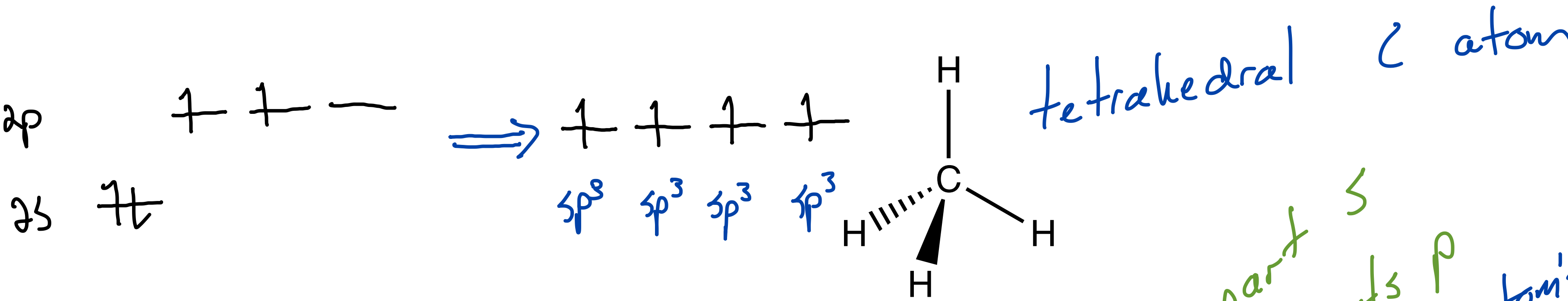
remember, this is a model & no model is perfect. MO theory uses the C's AO's as is.

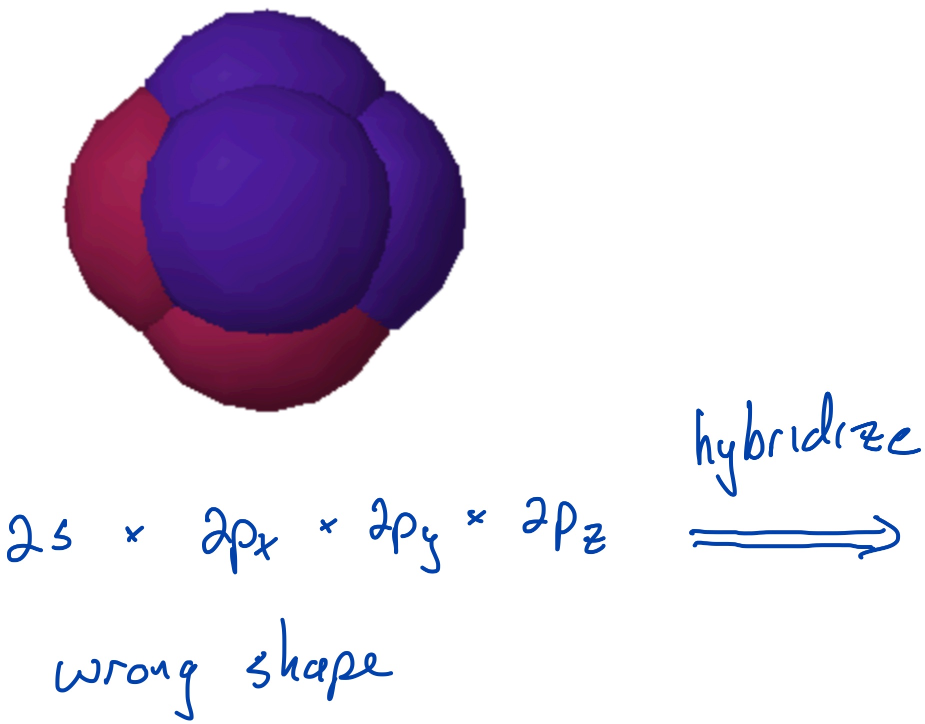
If angles are "wrong" and not all the orbitals have room for more electrons, how do 4 bonds form...

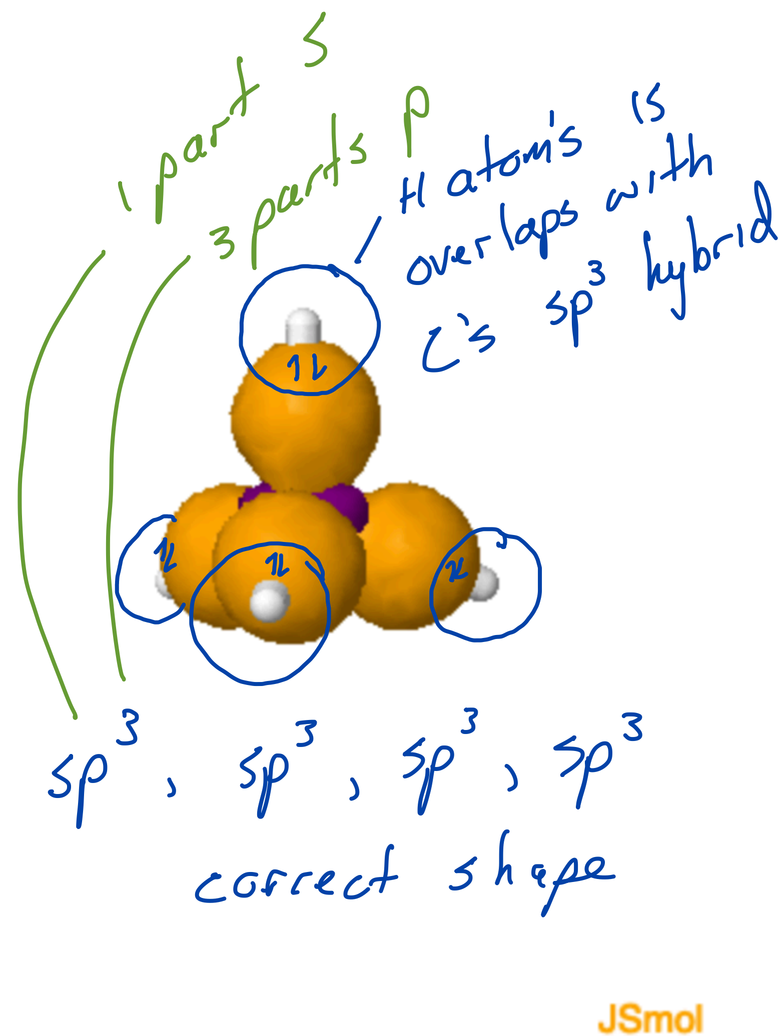
hybridization

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

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





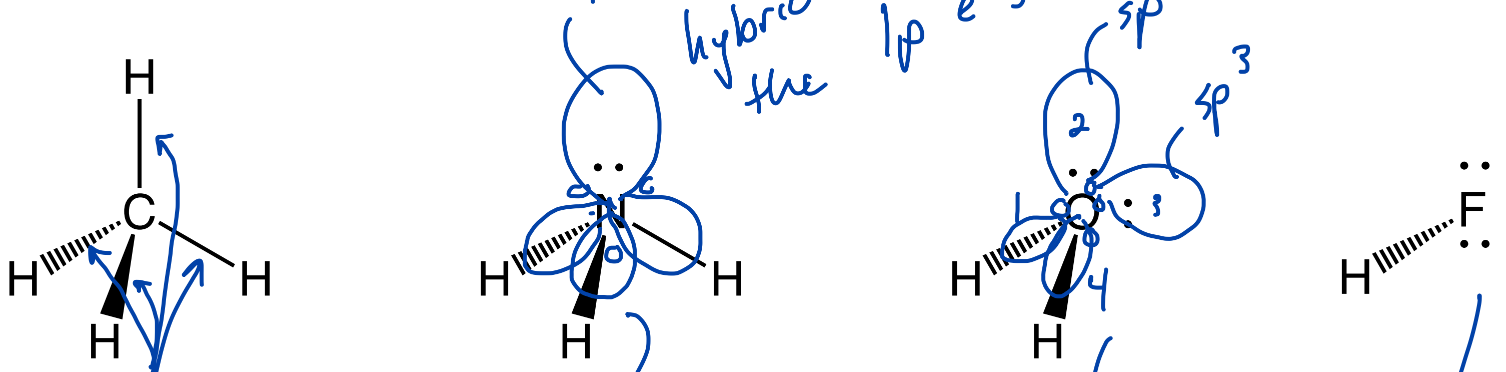


https://www.westfield.ma.edu/cmasi/organic/hybrid/hybrid.html Identify atoms that use sp^3 hybrid orbitals to form bonds and hold lone-pair electrons

Single bonds, lone-pair electrons, and hybrid orbitals

Section 1.7, 1.11, 1.12, 1.13

this sp^3 hybrid holds the lp e^-'s



made from an sp^3 hybrid (HO) on C and an s orbital on H overlapping + sharing 2 e^-'s

this N is sp^3 hybridized to

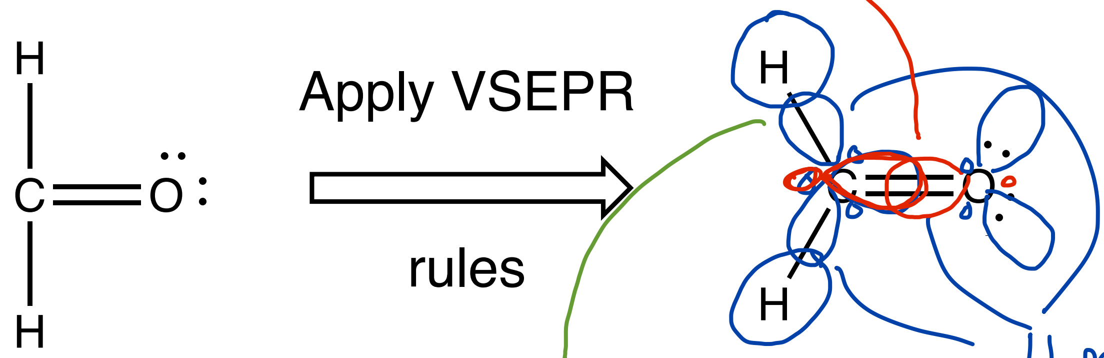
4 sets of e^-'s around a central atom... VSEPR says point them towards the corners of a tetrahedron, so sp^3

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

Double bonds and sp^2 hybridization

σ bond

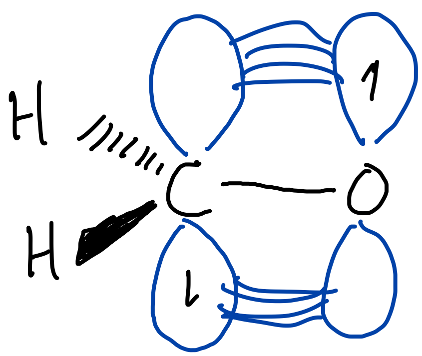
sp^2 HO on C overlaps with sp^2 HO on O an forms 1 bond by sharing 2 e^-'s



C's sp^2 HO overlaps with H's AO and they share 2 e^-'s

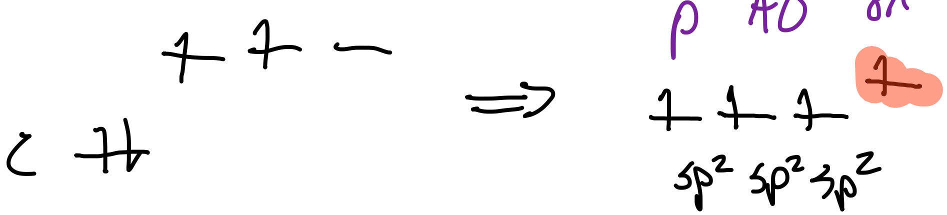
three sets of e^-'s that need to point in different directions

sp^3? 4 sp^3 orbitals? NO



the 2nd C to O bond is made by allowing the remaining unhybridized p AO on C overlap with the p AO on O

π bond



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

Identify atoms that use sp^2 hybrid orbitals to form bonds and hold lone-pair electrons

Triple bonds and sp hybridization

2s + 2pz 2px , 2py → sp sp , 2px + 2py

sp overlaps with H's is .... bond

σ bond

sp hybridization

sp on C overlaps with sp on other C ..... bond

σ bond

https://www.westfield.ma.edu/cmasi/organic/hybrid/hybrid3.html

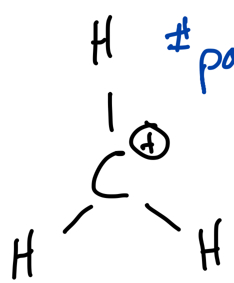
Identify atoms that use sp hybrid orbitals to form bonds and hold lone-pair electrons

The methyl cation, anion, and radical

sp^2 hybridized C atom

CH_3^+

$\#\ \sigma$ bonds = 3



$\#$ pairs of lp e^-'s = 0

HO's needed = 3

2s + 2p + 2p

⇓

sp^2, sp^2, sp^2

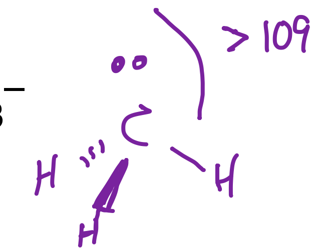
$FC_C = 4 - \#\ ab$

$1 = 4 - \#\ ab$

$3 = ab$

sp^3

CH_3^-



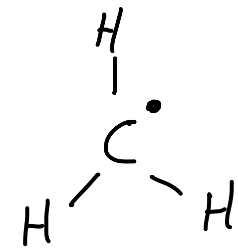
3 σ bonds

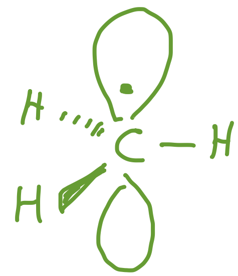
1 pair lp e^-'s

4 HO's needed

$2s + 2p_x + 2p_y + 2p_z$

$CH_3^\bullet$





3 σ bonds

0 pair lp e^-'s

3 HO's needed

$2s + 2p_x + 2p_y$ $2p_z$

⇓

sp^2, sp^2, sp^2

Determine the hybridization of unusual molecular fragments hybrid orbitals are used to form σ bonds and to hold lone-pair electrons

single bonds are always σ bonds

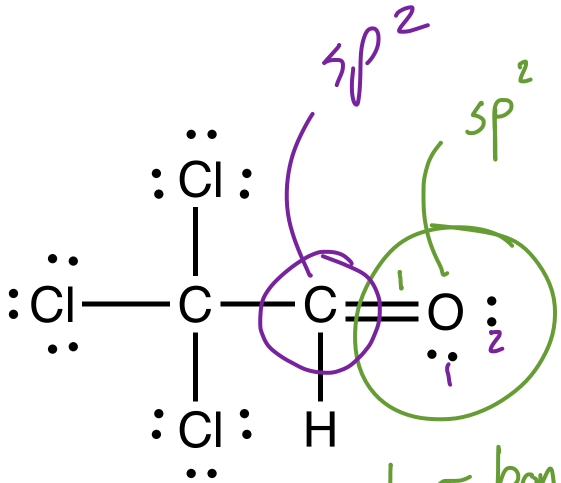
double and triple bonds are formed from σ bonds and π bonds

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

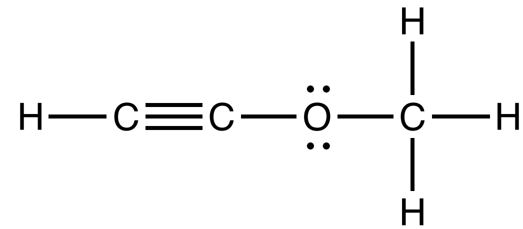
count out the # of atomic orbitals need to make the hybrid orbitals starting with the 2s orbital (or 3s if appropriate)

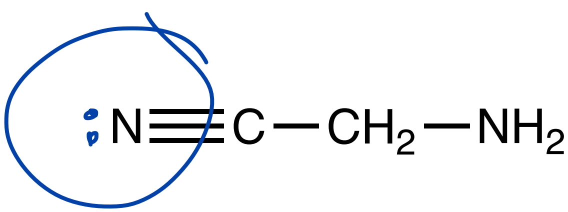
name the hybrid orbitals sp^n where n is the number of p orbitals used

Practice



1 σ bond
2 pairs lp e⁻'s
3 HOs needed



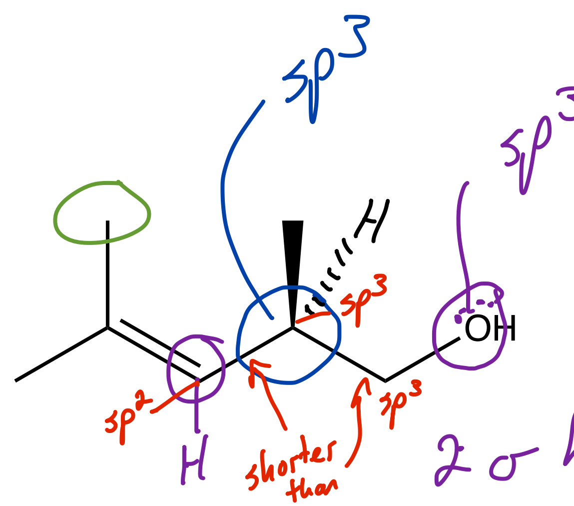


$2s + 2p \Rightarrow sp, sp$

sp

1 pair lp e⁻
1 σ bond
2 HOs needed

2 π bonds

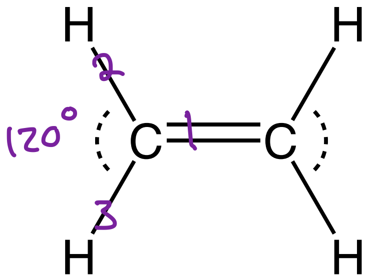


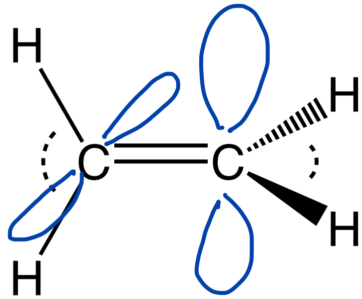
2 σ bonds
2 pair lp e⁻'s
4 HO's needed

handful sp2

0 sp

handful sp3 ?

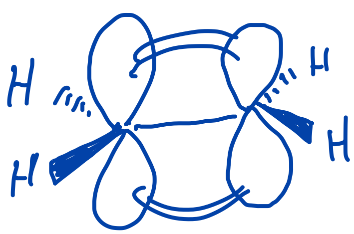


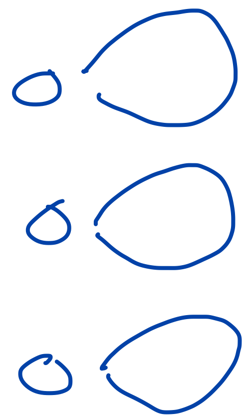


trigonal planar   trigonal planar   both C's are trigonal planar

which is correct?

db is made from 2 bonds
1 σ bond + 1 π bond ← overlapping p orbitals





sp^3 25% s + 75% p

sp^2 33% s + 67% p

sp 50% s + 50% p

e^-'s in sp hybrids get closest to nucleus + makes the e^- most stable out of sp vs sp^2 vs sp^3

So an sp^3 to sp^2 bond would be shorter + stronger than an sp^3 to sp^3 bond.

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