(4) Today

Sections 1.5-1.10
Valence Bond Theory

Skipping Section 1.11 for now
An introduction to Molecular Orbital Theory

Sections 1.12
Drawing Chemical Structures

Next Class (5)

Sections 1.12
Drawing Chemical Structures

(6) Second Class from Today

Sections 2.1 - 2.4
Polar Covalent Bonds, Formal Charges,
Resonance/Electron Delocalization

Sections 2.4 – 2.6
Resonance/Electron Delocalization

Third Class from Today (7)

Sections 2.1 - 2.4
Polar Covalent Bonds, Formal Charges,
Resonance/Electron Delocalization

Sections 2.4 – 2.6
Resonance/Electron Delocalization

Sections 2.7 – 2.11
Acids and Bases

Use the periodic table to determine electron configurations ✓

Use the periodic table to determine the number of valence electrons ✓

Use the periodic table to identify metals and non-metals ✓

Use the periodic table to remember trends in size ✓

Use the periodic table to remember trends in electronegativity ✓

Use the periodic table to predict likely charges of ions ✓

Use the periodic table to predict likely bond formation ✓

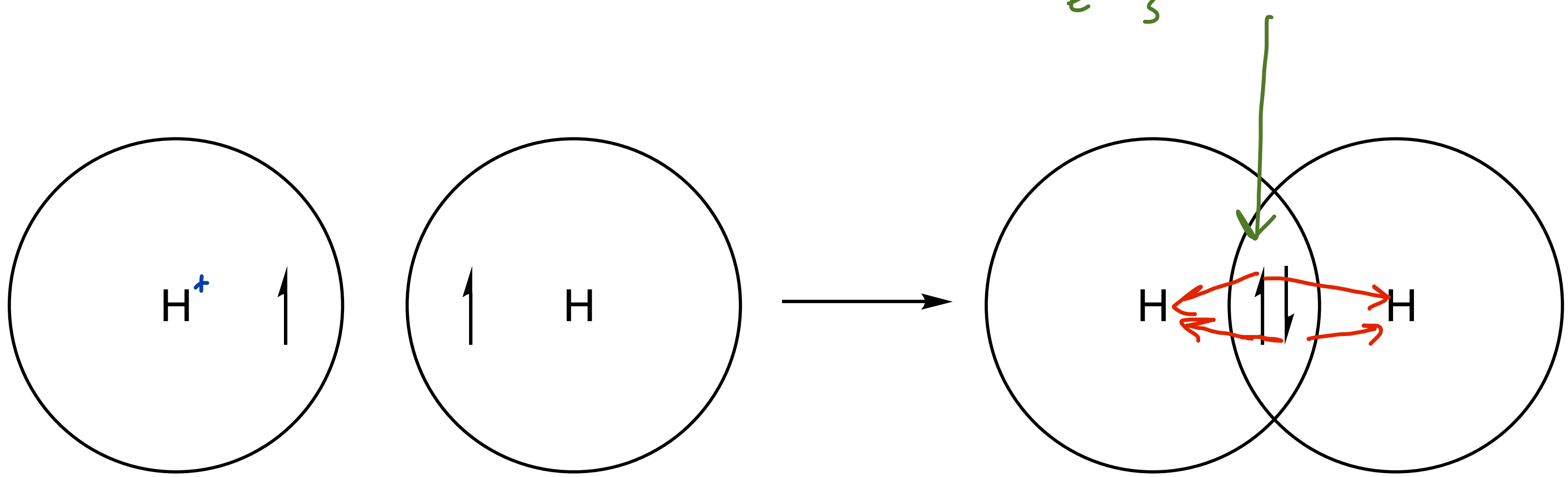
Use trends in size, electron configuration, and nuclear charge to explain electronegativity trend ✓

Introduce Valence Bond Theory (hybridization)

Different Ways of Representing Chemicals

$H—H$

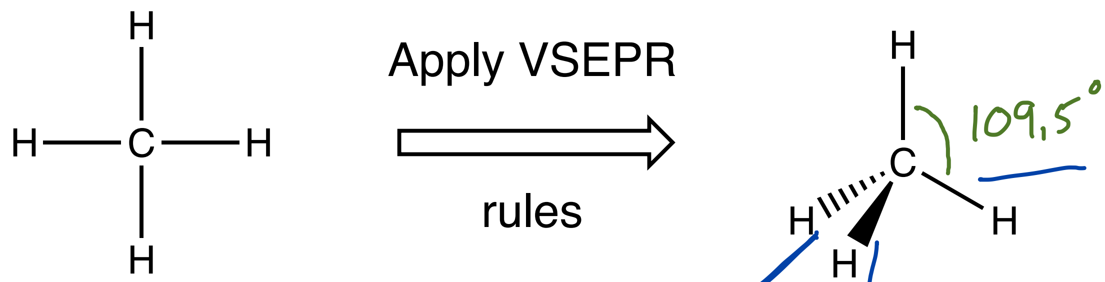
mutual attraction for a pair of shared e^-'s



$1s^1$ $1s^1$

room for another e^- room for another e^-

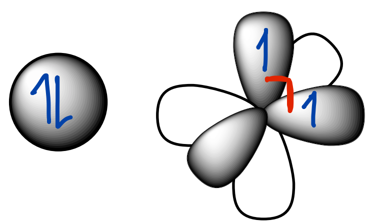
1s orbitals overlap... each H atom has room for 1 more e^-



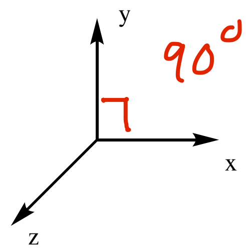
in the plane of the screen

this means the bond sticks out towards the viewer

means the bond sticks out away from the viewer



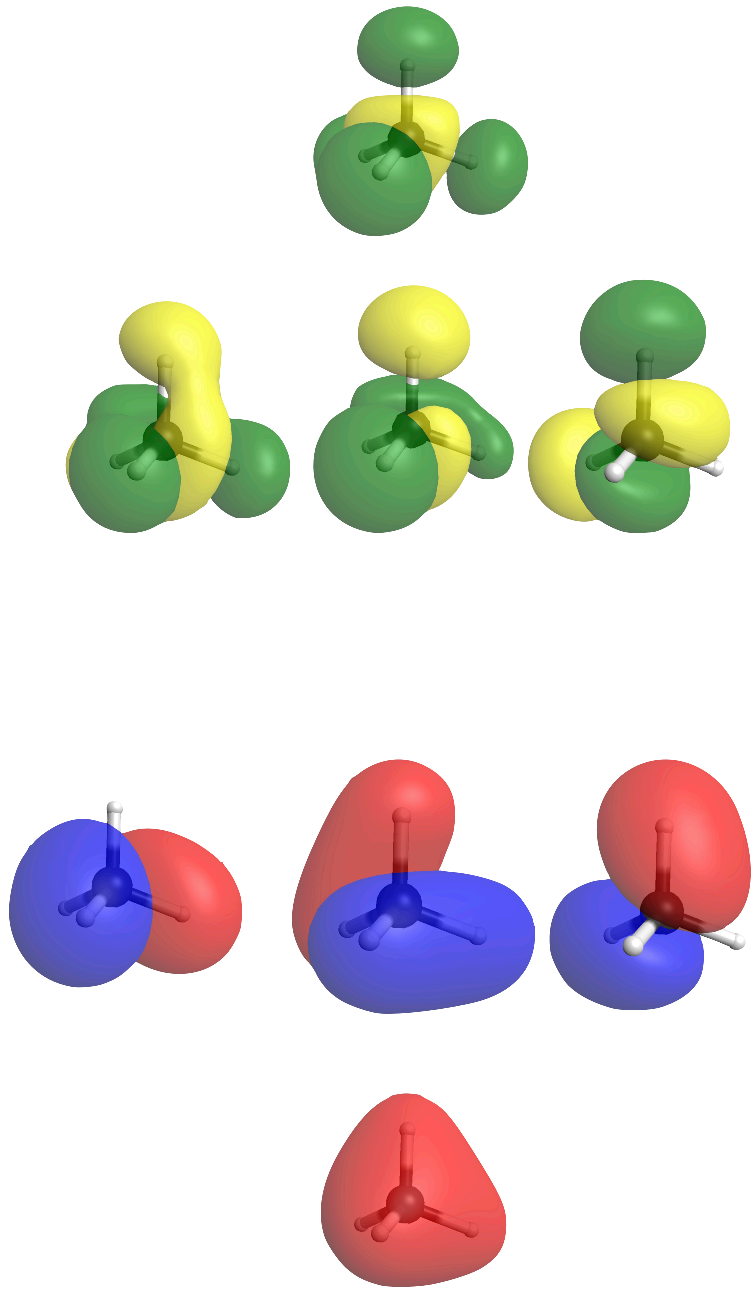
2s 2p$_x$, 2p$_y$, 2p$_z$



C atoms atomic orbitals are not the right shape

Just a Reminder that what I just said about orbitals being the "wrong" shape isn't a problem in MO theory

one 2s orbital
and
three 2p orbitals
from
one C atom

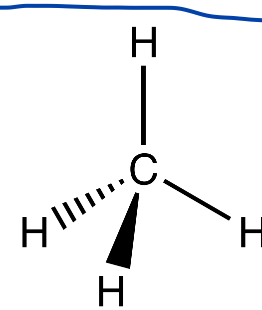


four 1s orbitals
from
four H atoms

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

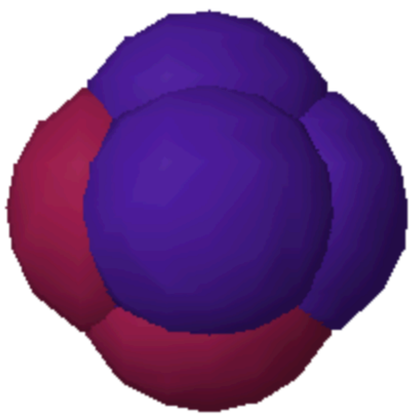
4 atomic orbitals don't have the right geometry

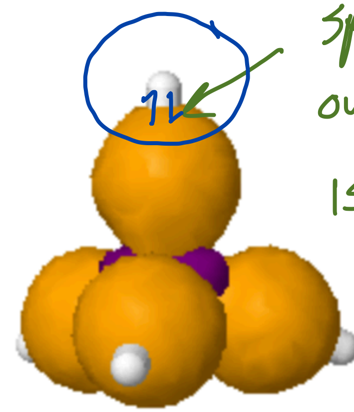
mix together →



4 new orbitals made by hybridizing the atomic orbitals

to create 4 new orbitals



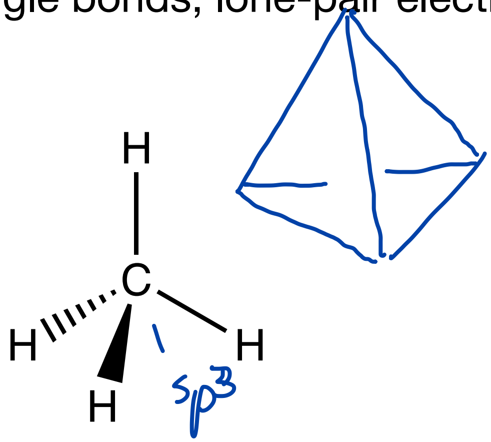


sp^3 of C overlaps with 1s of H to share e^-'s + form a σ bond

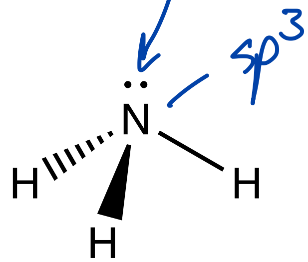
$2s + 2p_x + 2p_y + 2p_z \longrightarrow sp^3, sp^3, sp^3, sp^3$

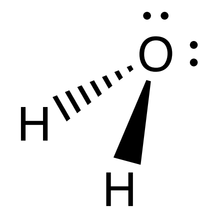
https://www.westfield.ma.edu/PersonalPages/cmasi/organic/hybrid/hybrid.html

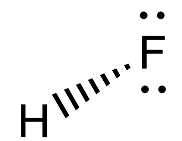
Identify atoms that use sp^3 hybrid orbitals to form bonds and hold lone-pair electrons



these e⁻'s are in an sp3 hybrid







4 σ bonds

4 sets of e⁻'s repelling

3 σ bond + 1 pair lp e⁻

4 sets of e⁻ repelling

2 σ bonds + 2 sets lp e⁻

4 sets of e⁻ repelling

1 σ bond + 3 sets of lp e⁻

4 sets of e⁻ repelling

4 HO's need

1 part s, 3 parts p

2s + 2px + 2py + 2pz

sp3

4 HO's need

1 part s, 3 parts p

2s + 2px + 2py + 2pz

sp3

Identify atoms that use sp³ hybrid orbitals to form bonds and hold lone-pair electrons

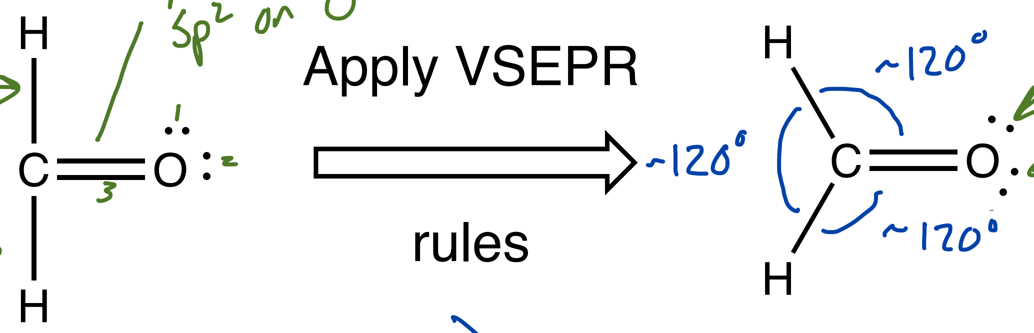
Double bonds and sp^2 hybridization

sp^2 on C
1s on H

sp^2 on C
sp^2 on O

sp^2 on C
1s on H

lp e^- in sp^2 hybrid



C atom ... 3 sets ... 3 HO

3 σ bonds

$2s + 2p_x + 2p_y \Rightarrow sp^2, sp^2, sp^2$

unhybridized $2p_z$

O atom ... 3 sets ... 3 HO's

1 σ bonds + 2 pair lp e^-'s

$2s + 2p_x + 2p_y \Rightarrow sp^2, sp^2, sp$

unhybridized $2p_z$

sp^2 hybrid on C + sp^2 hybrid on O form a σ bond

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

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

unhybridized 2p on C + unhybridized 2p on O form a π bond sp on C and sp on C overlap and form a σ bond

left C atom

2 sets... 2 HO's needed

2 σ bonds

$2s + 2p_z \Longrightarrow sp, sp$

$2p_x, 2p_y$

right C atom

2 sets... 2 HO's needed

2 σ bonds

$2s + 2p_z \Longrightarrow sp, sp$

$2p_x, 2p_y$

parallel so they overlap and form a π bond

same here!

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

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

The methyl cation, anion, and radical

s × p × p

sp² hybridized

CH_3^+

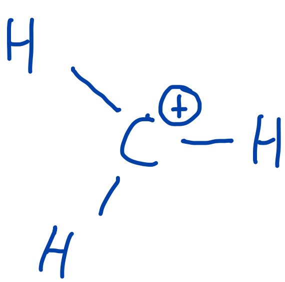
Lewis structure?

C 4 e⁻

3 H 3 e⁻

− 1 e⁻

6 e⁻



s × p × p × p

CH_3^-

sp³

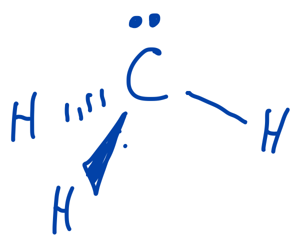
C 4 e⁻

3H 3 e⁻

7 e⁻

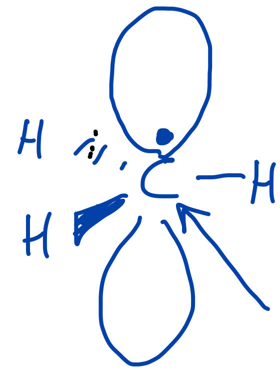
+ 1 e⁻

8 e⁻



radical

$CH_3^\bullet$



C atom is sp² hybridized

3 σ bonds ....

3 HO

s × p × p

Determine the hybridization of unusual molecular fragments