(7) **Today**

Sections 1.5 - 1.10
Valence Bond Theory

Sections 1.12
Drawing Chemical Structures

Next Class (8)

Sections 1.12
Drawing Chemical Structures

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

Bring Modeling Kits

(9) **Second Class from Today**

Sections 2.4 – 2.6
Resonance/Electron Delocalization

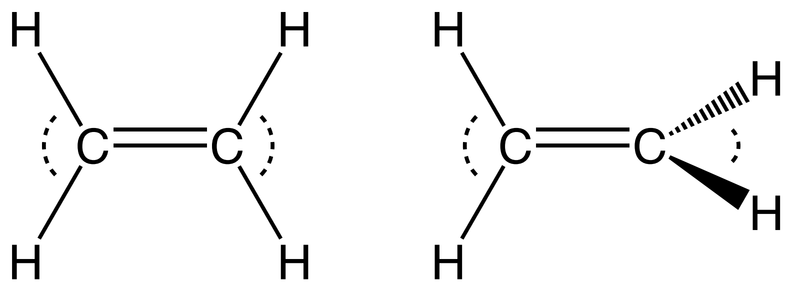
Bring Modeling Kits

Third Class from Today (10)

Sections 2.4 – 2.6
Resonance/Electron Delocalization

Sections 2.7 – 2.11
Acids and Bases

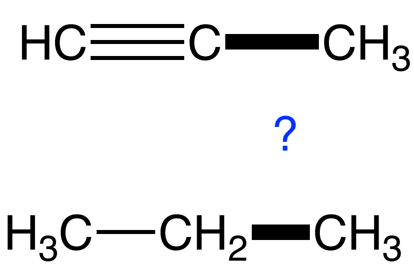
What can we use Valance Bond Theory for?



Which one? Both C atoms are trigonal planar

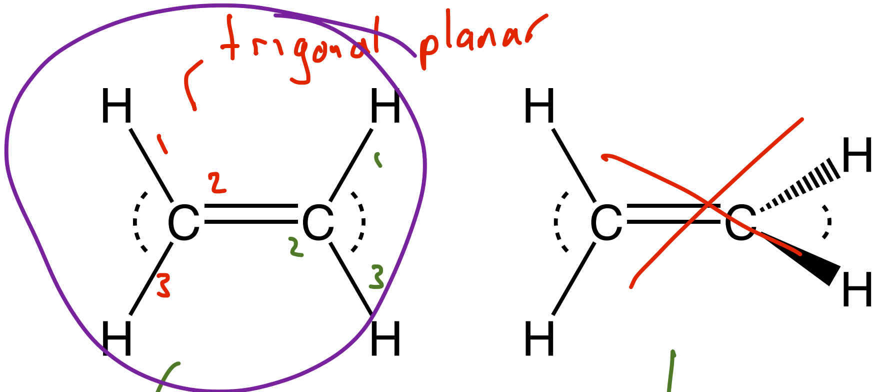
Why is there free rotation around C to C single bonds but not C to C double bonds?

Which bond is stronger?



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

What can we use Valance Bond Theory for?



Hybridization of the C's

2s 2px 2py | 2pz

⇓

sp^2_{xy} sp^2_{xy} sp^2_{xy} $2p_z$

2s | 2px | 2py 2pz

⇓

sp^2_{yz} sp^2_{yz} sp^2_{yz} $2p_x$

per

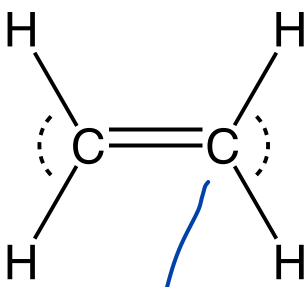
Which one? Both C atoms are trigonal planar

coplanar triangles works
- p orbitals are parallel to each other
- they overlap
- they share e⁻
- 2nd bond ✓

intersecting triangles don't work because the unhybridized p orbitals
- would be perpendicular
- they don't overlap
- they don't share e⁻
- which means no 2nd bond

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

What can we use Valance Bond Theory for?



Which one? Both C atoms are trigonal planar

$H-C\equiv C-H$

db is made from a σ bond + π bond

triple bond is made from $\sigma + \pi + \pi$

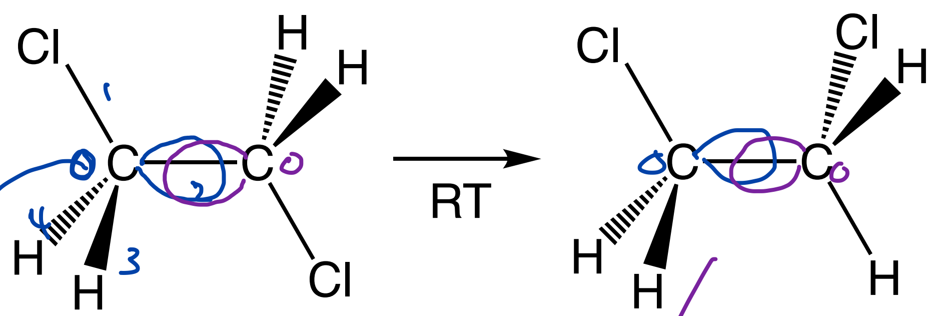
the double bond is formed when an sp^2 hybrid on the left C overlaps with an sp^2 hybrid on the right C to share e^-'s and form a σ bond

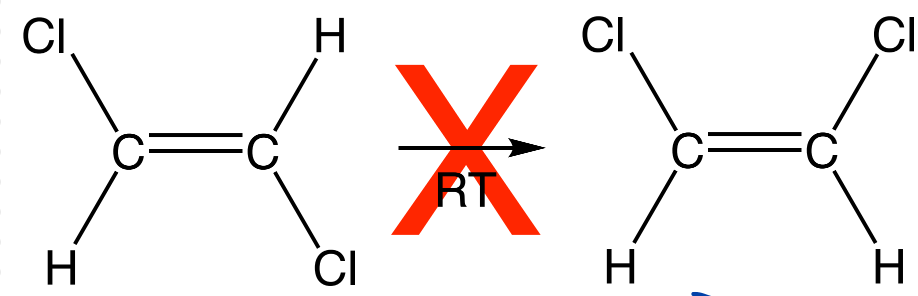
the unhybridized p orbital on the left C overlaps with an unhybridized p orbital on the right C to share e^-'s and form a π bond

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

What can we use Valance Bond Theory for?

Why is there free rotation around C to C single bonds but not C to C double bonds?





# of directions
# of orbitals
mix starting at 2s

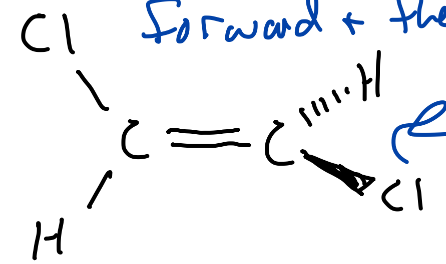
2s + 2px + 2py + 2pz

⇓

sp^3 sp^3 sp^3 sp^3

rotating along the C to C bond doesn't change the orientation of the sp^3 orbitals that are overlapping, so rotating has no affect on the bond

grab the Cl an rotate it forward + then up



to do the rotation, the orientation of the p orbitals would have to change, and they wouldn't overlap...

To rotate the π bond would have to break

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

What can we use Valance Bond Theory for?

Which bond is strongest?

Bond dissociation E

$H_3C{-}CH_2{-}CH_3$	$H_2C{=}CH{-}CH_3$	$HC{\equiv}C{-}CH_3$
370 kJ/mol[1], 355±8 kJ/mol[2]	426 kJ/mol[1]	490 kJ/mol[3]
weakest		strongest
sp^3 – sp^3	sp^2 – sp^3	sp – sp^3
sp^3	sp^2	sp
25% s, 75% p	33% s, 67% p character	50% s, 50% p

e⁻'s get closer to nucleus so they are more stable so the sp to sp^3 bond is strongest

BDE

$H{-}H \longrightarrow H\cdot \quad H\cdot \qquad \Delta H = ?$

[1] Organic Chemistry, 10th ed. McMurry.

[2] Chem. Rev. **66**, 465 (1966).

[3] J.Chem.Ed. **42**, 502 (1965)

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

in the valence bond model, single bonds are always σ bonds

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

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

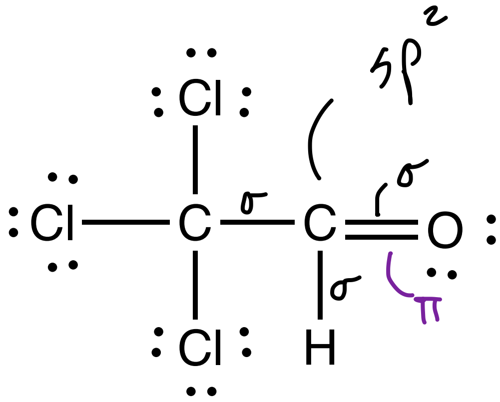
count out the # of atomic orbitals need to make the hybrid orbitals starting with the 2s orbital (or 3s if appropriate) adding in 2p orbitals as needed

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

↑ number of p   mixed in

any unhybridized p orbitals will be used to make π bonds

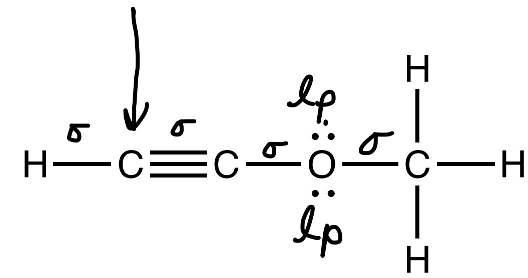
Practice



C: σ + σ + σ = 3

2s 2p 2p

sp^2



C: 1σ + 1σ = 2 HO's

2s 2p

⇓

sp

O: σ + σ + lp + lp = 4 HO's

2s 2p 2p 2p

⇓

sp^3

$N\equiv C-CH_2-NH_2$