

Previously in Molecularity . . .

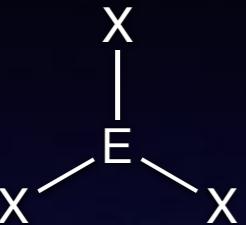
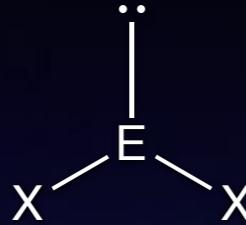
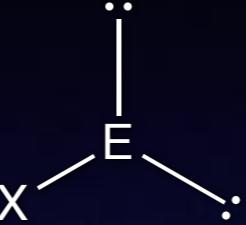
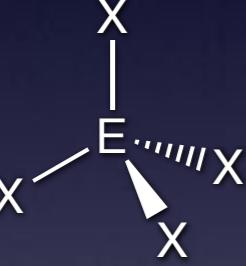
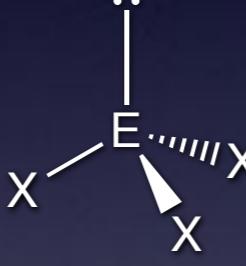
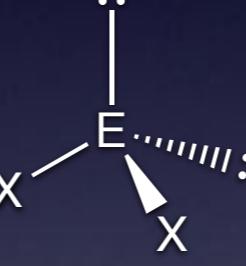
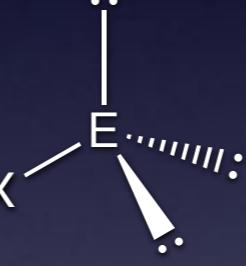
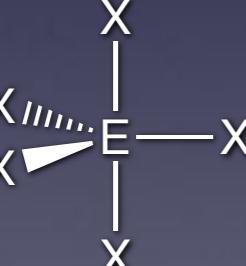
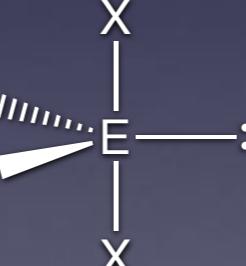
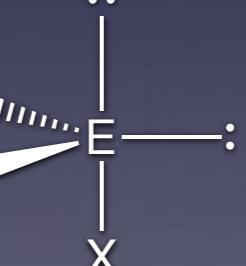
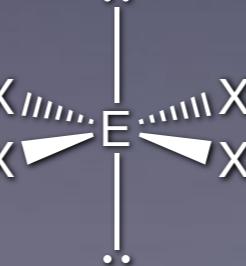
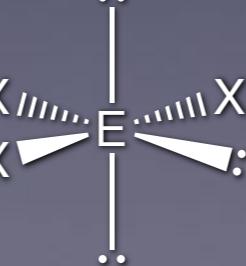
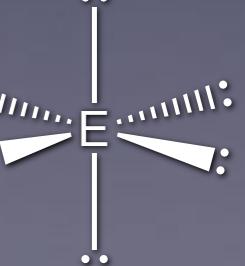
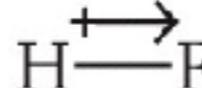
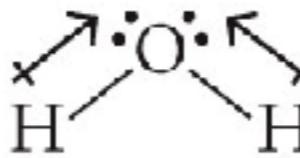
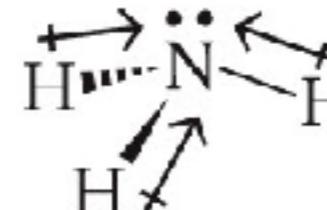
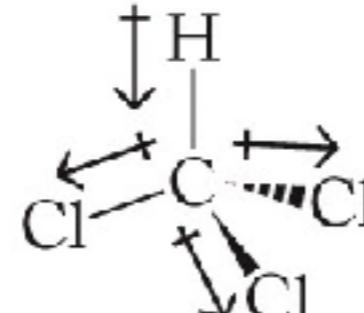
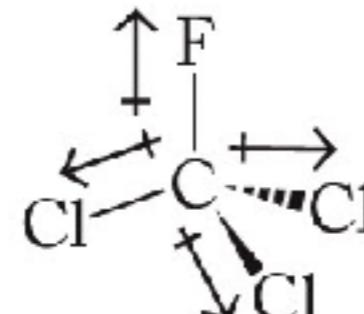
SN	0 LP	1 LP	2 LP	3 LP	4 LP	5 LP
2	$\text{X}-\text{E}-\text{X}$ Linear	$\text{X}-\text{E}-:$				
3	 Trigonal planar	 120° Bent				
4	 Tetrahedral	 Trig. pyramidal	 109.5° Bent			
5	 Trig. bipyrimidal	 See-saw	 T-shaped	 Linear		
6	 Octahedral	 Sq. pyramidal	 Sq. planar	 T-shaped		 Linear

TABLE 5.2 Permanent Dipole Moments of Several Polar Molecules

Formula	Structure with Bond Dipole(s)	Direction of Overall Dipole	Dipole Moment (debyes)
HF			1.91
H ₂ O			1.85
NH ₃			1.47
CHCl ₃			1.04
CCl ₃ F			0.45

To think about on your own...

- Would the following molecules have permanent dipoles? If so, in what direction and what might the dipole moment be?
 - Phosgene, COCl_2 ; XeCl_2Br_2 ; Methanol CH_3OH
- Do resonance structures change dipoles? Why or why not?
- Additionally, think about what bond lengths angles might be...
- Similar problems from Recitation 4...

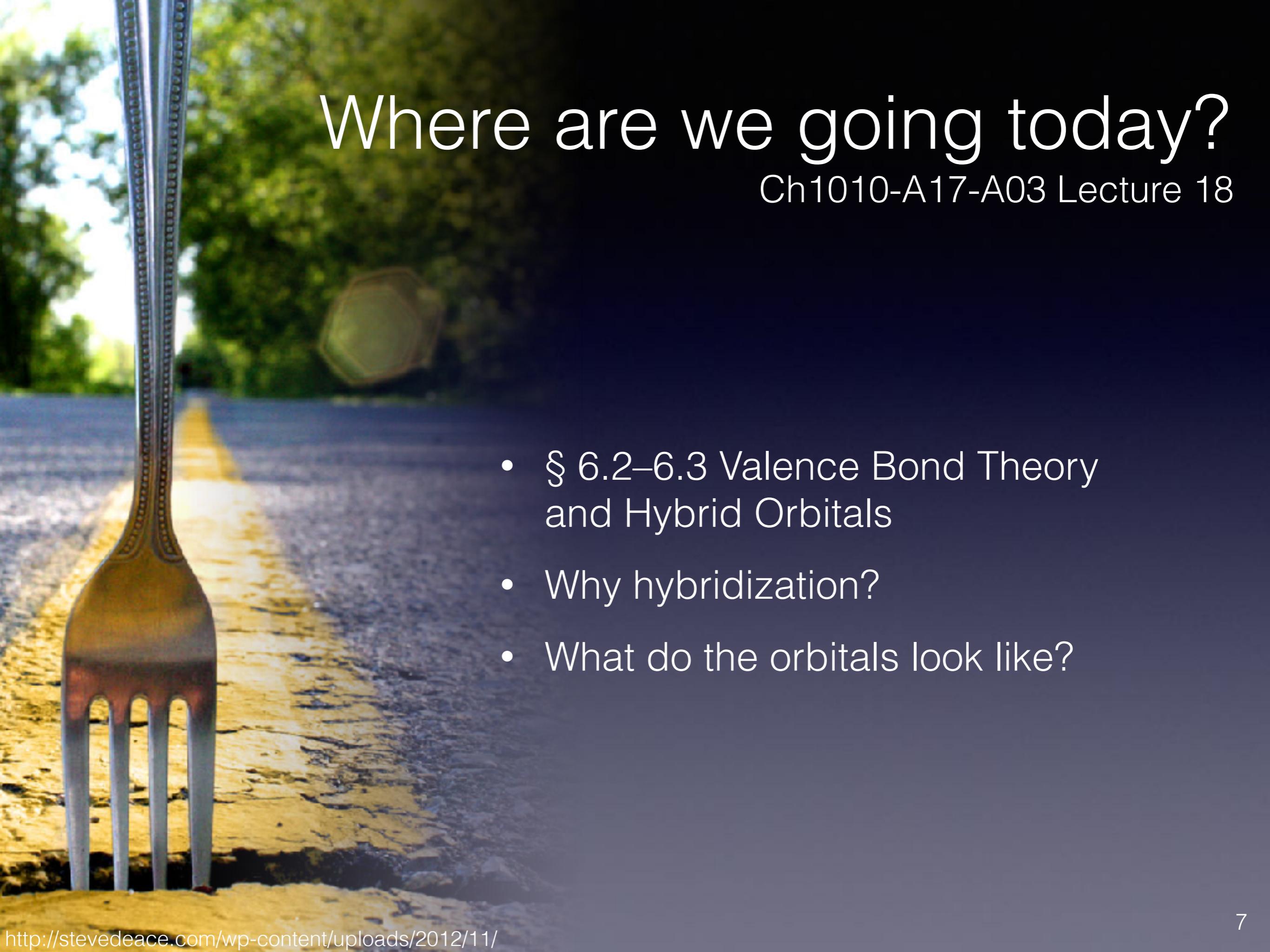
VSEPR Practice

- Draw the Lewis dot structure, VSEPR structure and provide the VSEPR structure name for:
 - Formaldehyde, CH₂O
 - Phosphine, PH₃
 - Ethene (ethylene), CH₂CH₂
 - Bromine pentachloride
 - Bromine trichloride

VSEPR Practice

- Draw the Lewis dot structure, VSEPR structure and provide the VSEPR structure name for:
 - Formaldehyde, CH₂O
 - Phosphine, PH₃
 - Ethene (ethylene), CH₂CH₂
 - Bromine pentachloride
 - Bromine trichloride

What are the polarities of these molecules?
How would they align in an electric field?

A photograph of a silver fork standing upright in a field of lavender. The fork's tines are pointing downwards and to the left. In the background, there is a paved road curving to the right, some trees, and a bright sky.

Where are we going today?

Ch1010-A17-A03 Lecture 18

- § 6.2–6.3 Valence Bond Theory and Hybrid Orbitals
- Why hybridization?
- What do the orbitals look like?

Orbital filling...

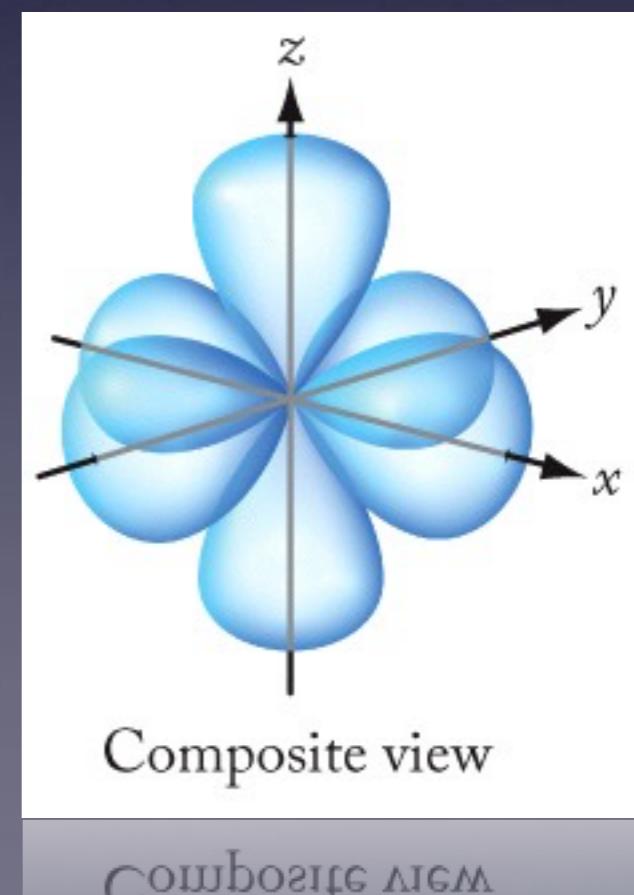
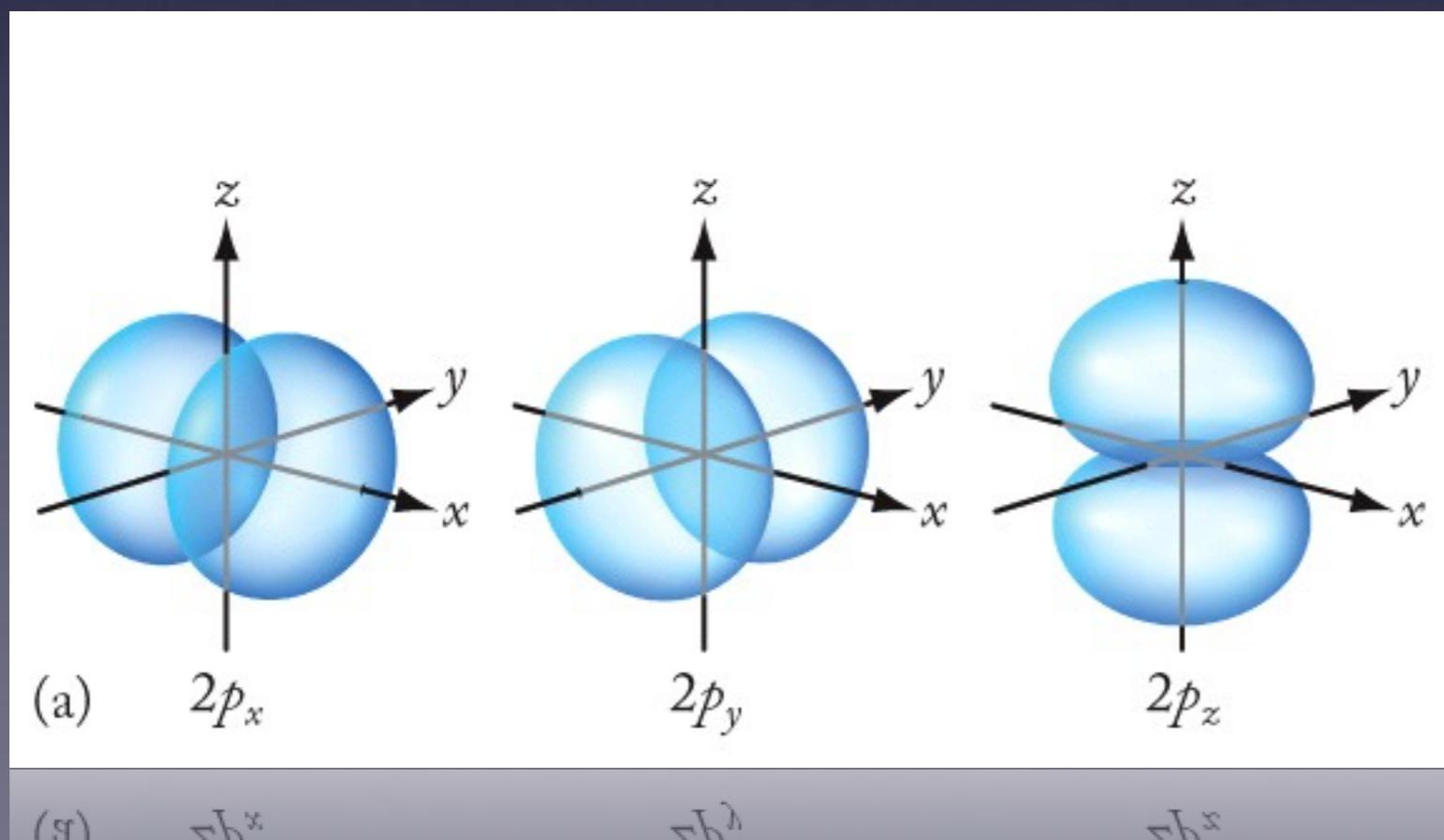
Carbon



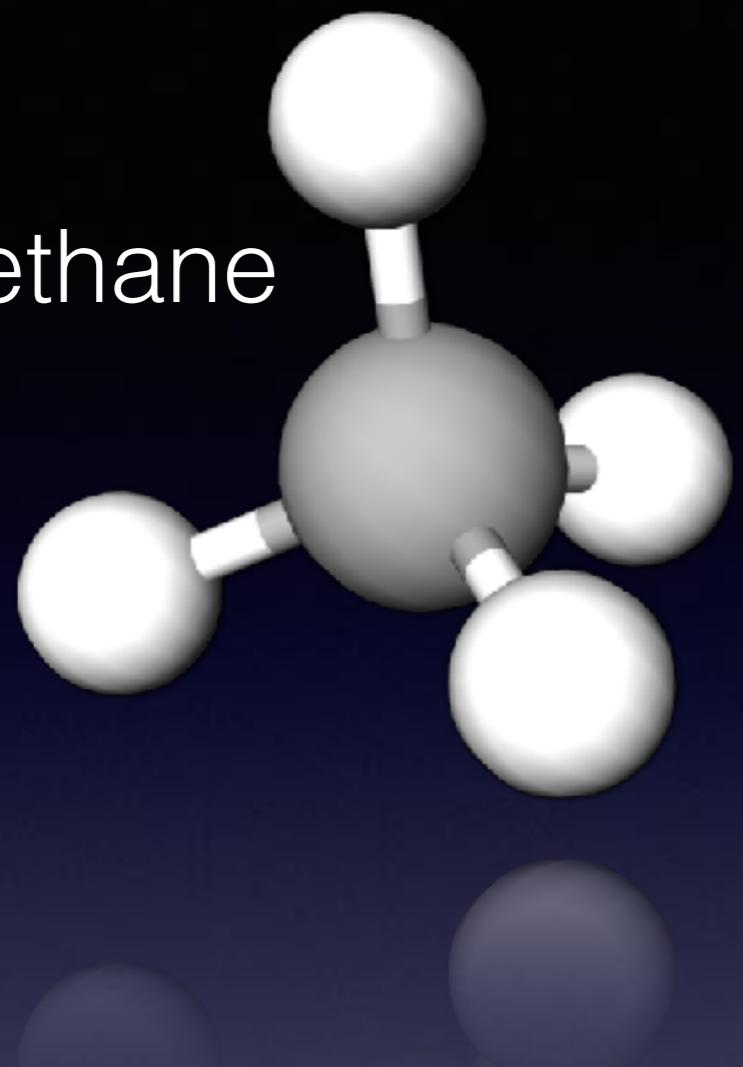
Nitrogen



Oxygen

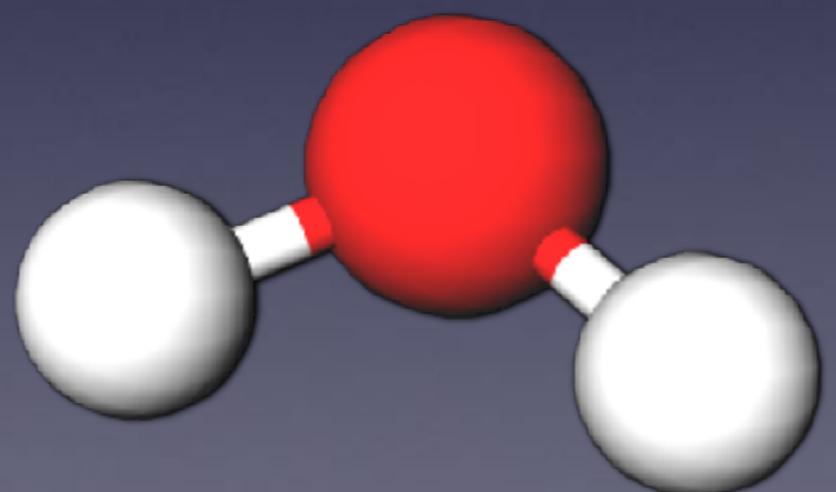
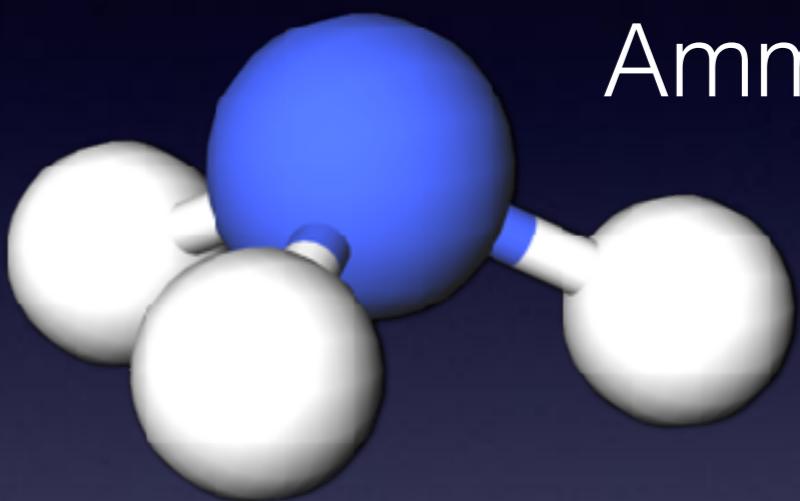


Methane



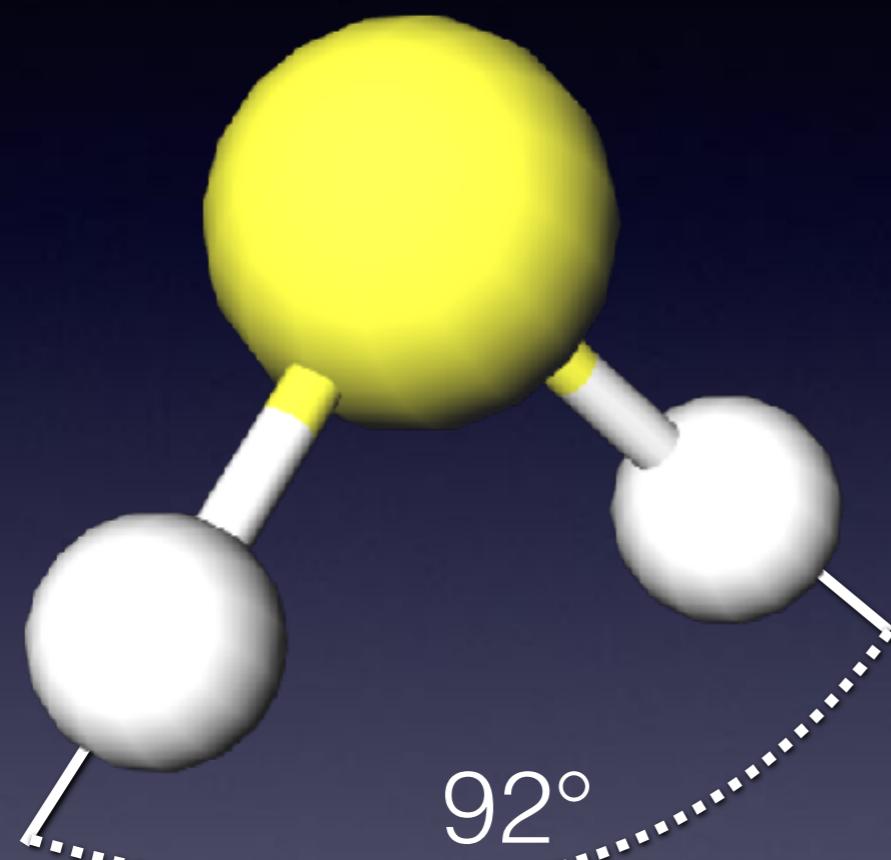
Why Hybridization 1

Ammonia

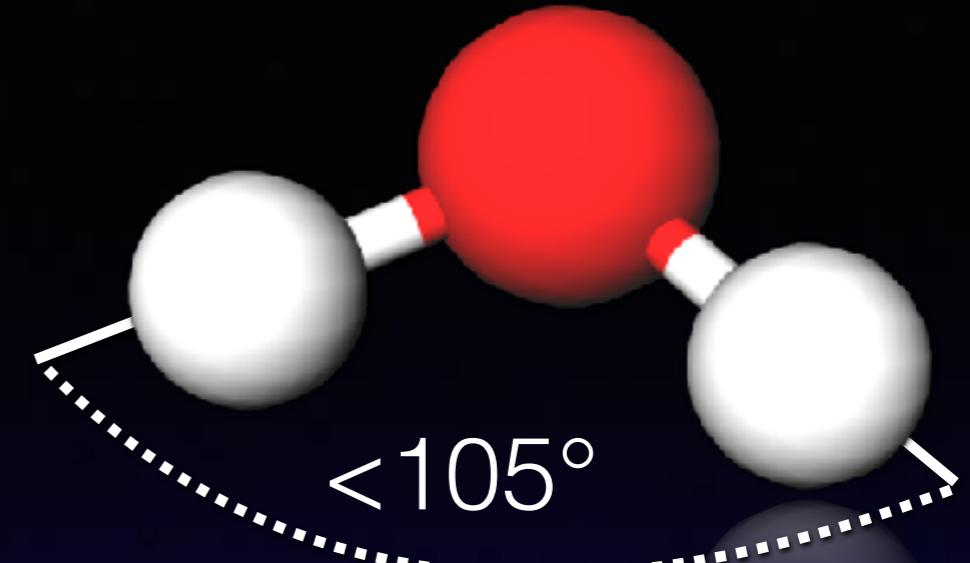


Water

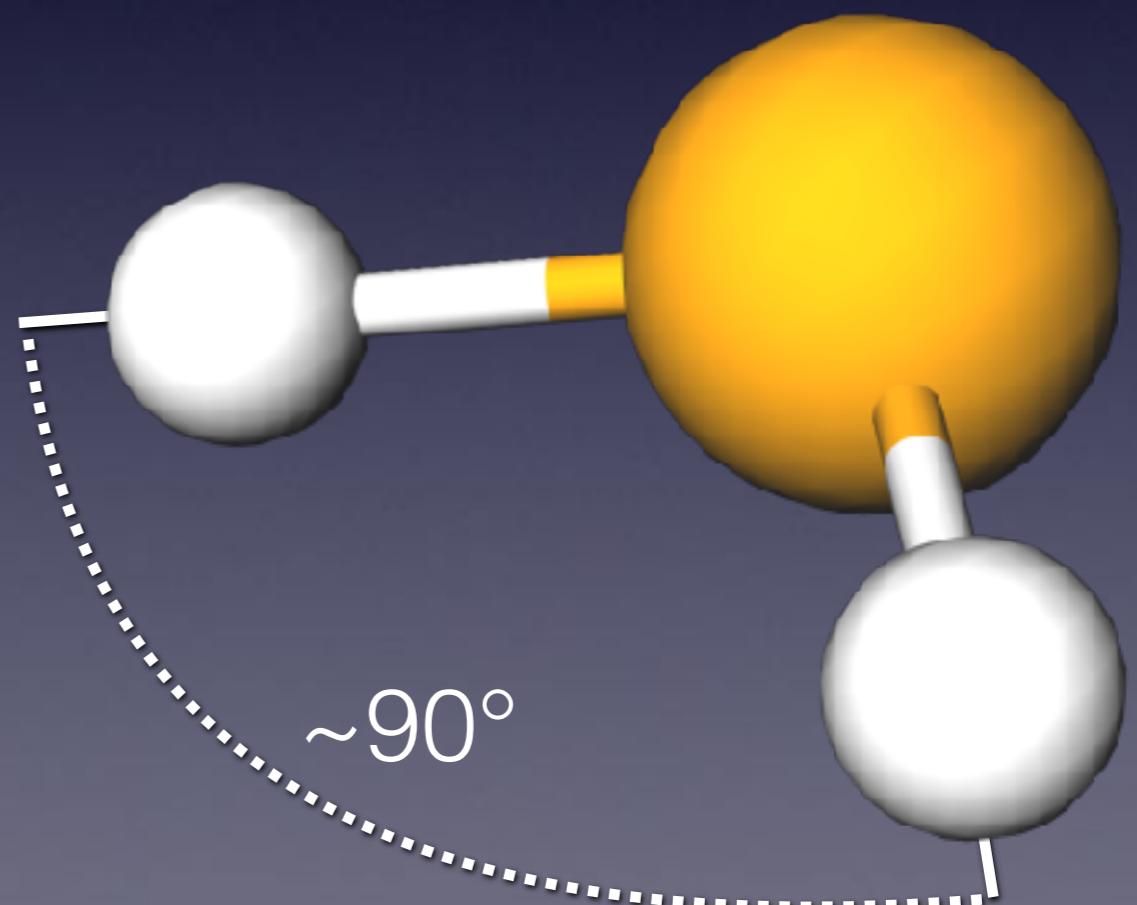
Why hybridization 2



Hydrogen sulfide, H_2S



Water, H_2O



Hydrogen selenide, H_2Se

Why hybridization?

Increase bonding

Maximize bond angles
(minimize steric repulsion)

How do orbitals hybridize?

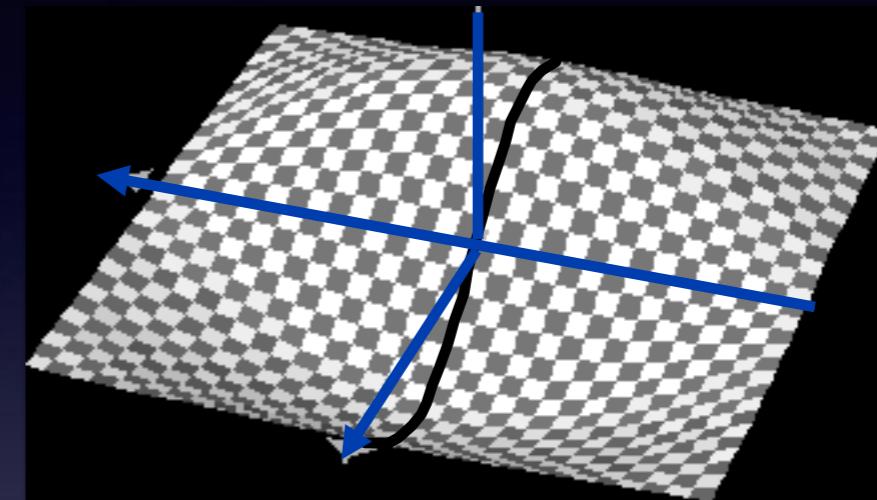
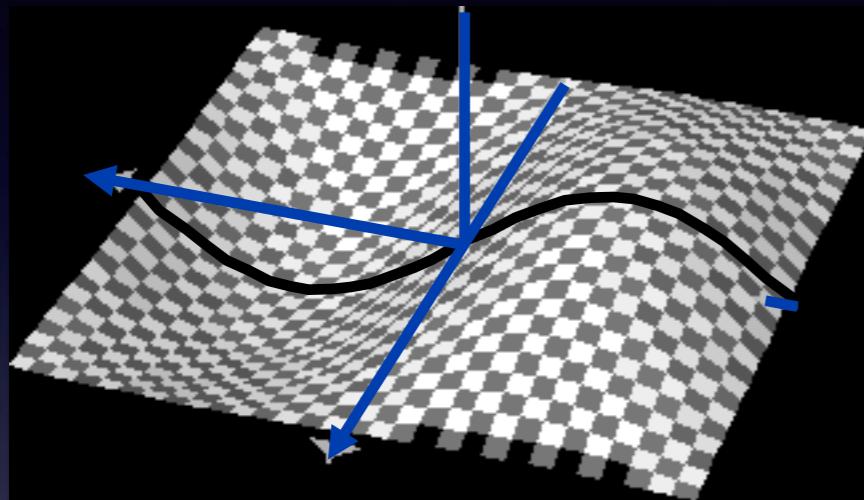
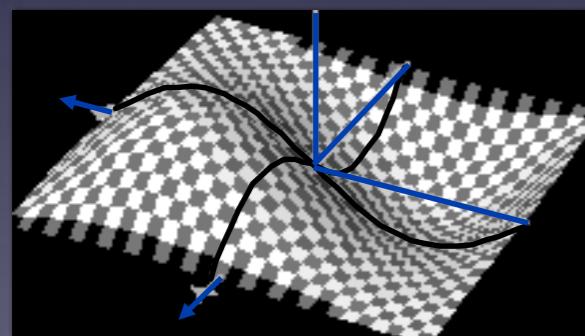
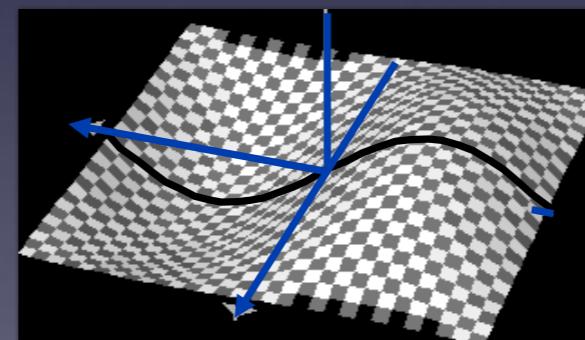


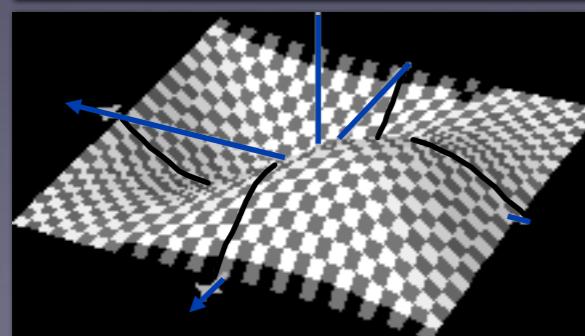
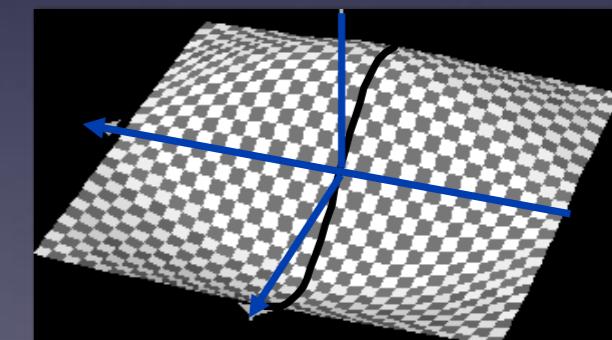
Image credit: Nate Lewis, Caltech



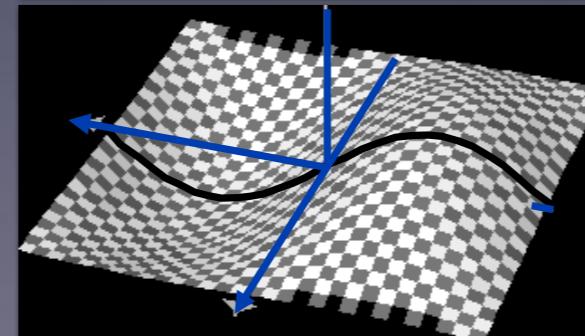
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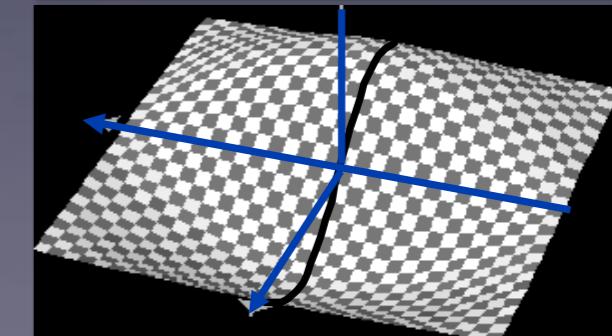
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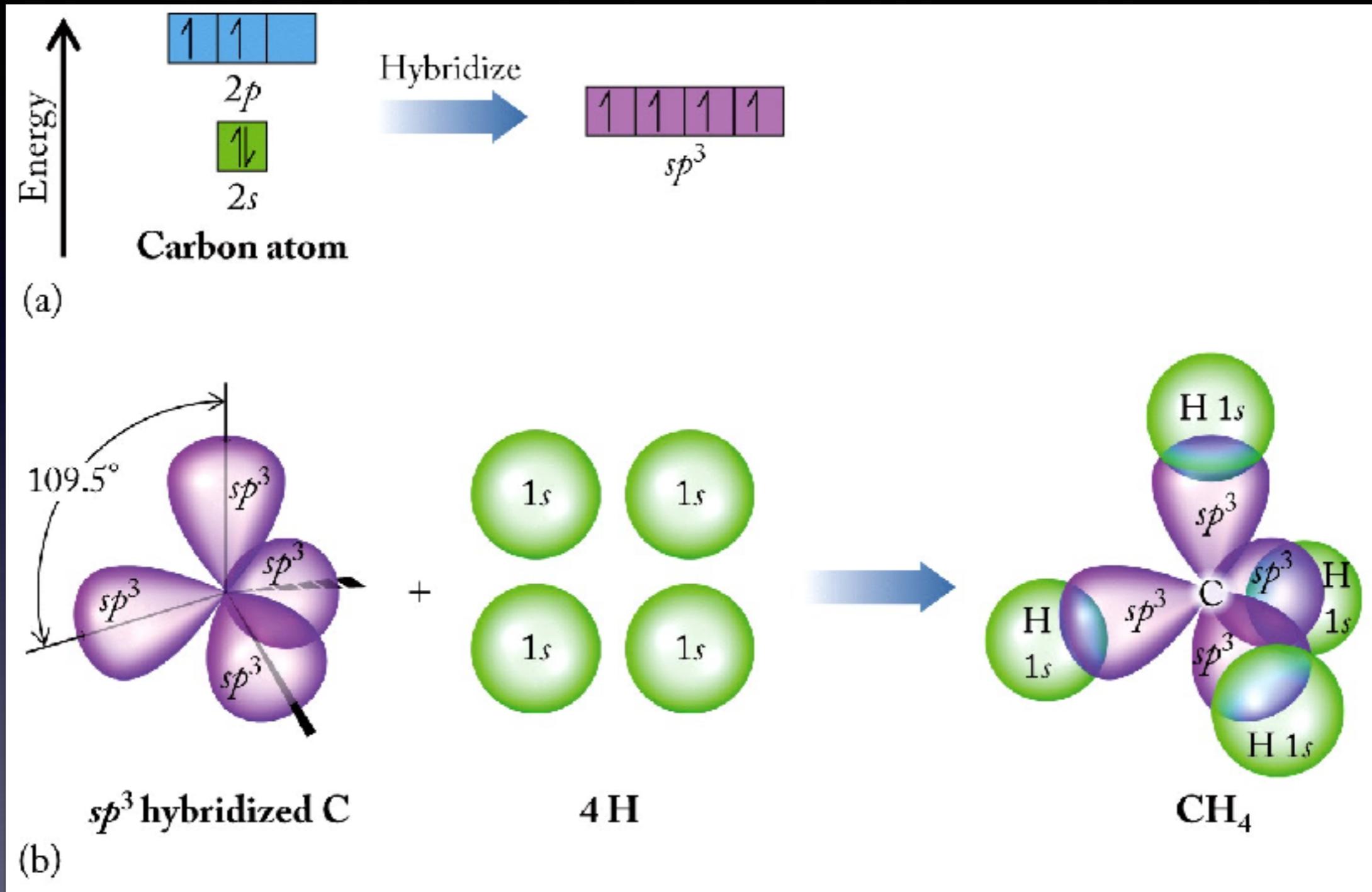
Orbital mixing rule:

x orbitals in

...

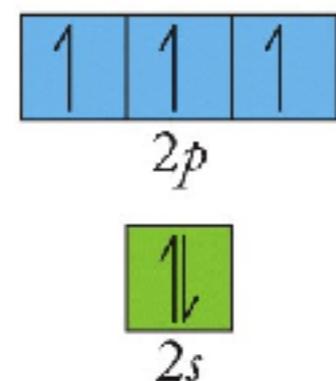
x orbitals out

This context is hybridization,
we'll revisit when making *molecular orbitals*

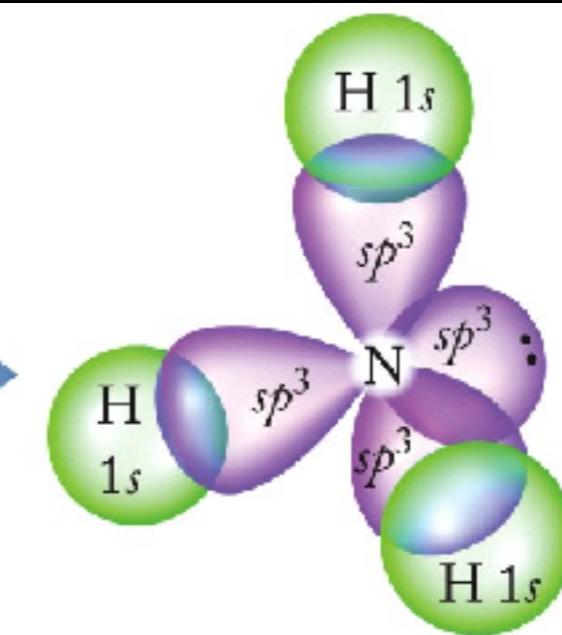
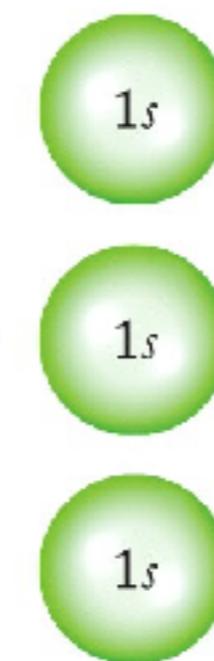
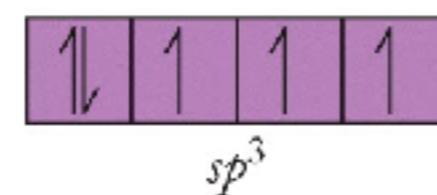


(p)

This is where the **tetrahedral** VSEPR structure comes from



Hybridize

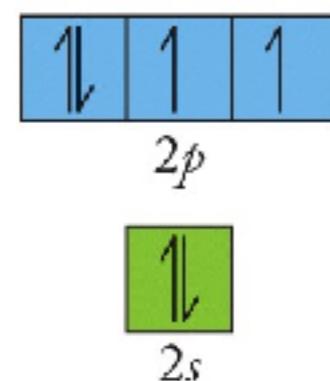


Unhybridized N
(a)

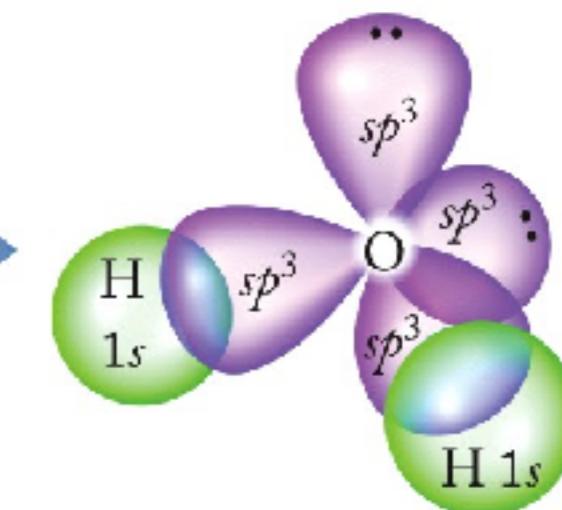
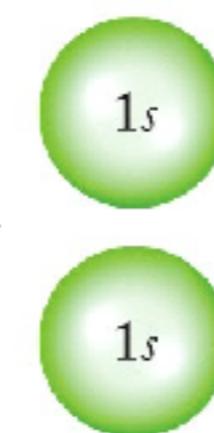
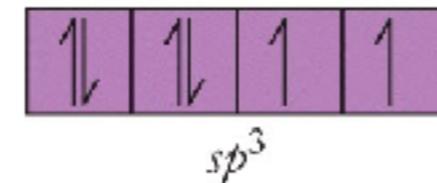
sp^3 hybridized N

3 H

NH_3



Hybridize



Unhybridized O
(b)

sp^3 hybridized O

2 H

H_2O

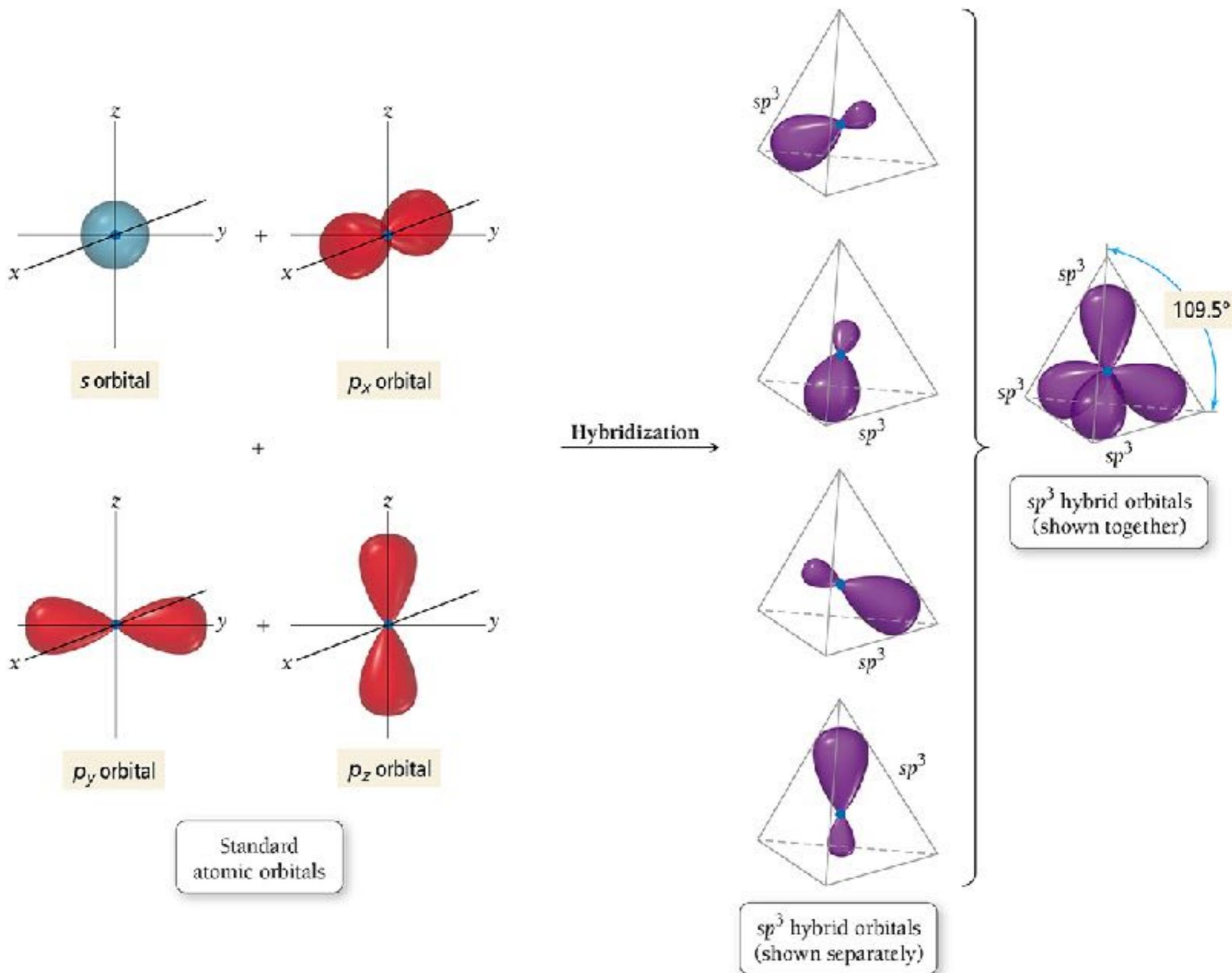
(p)

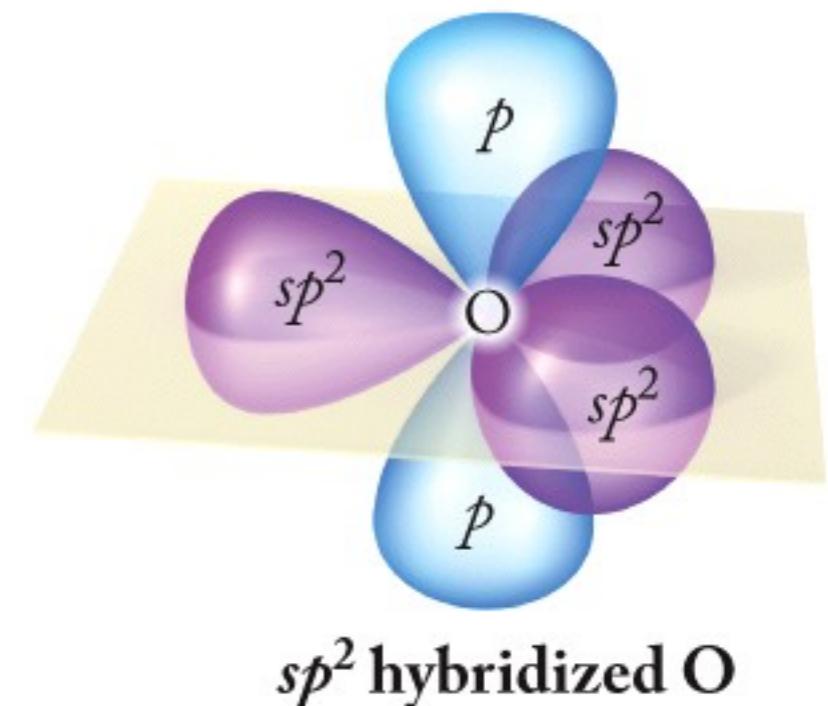
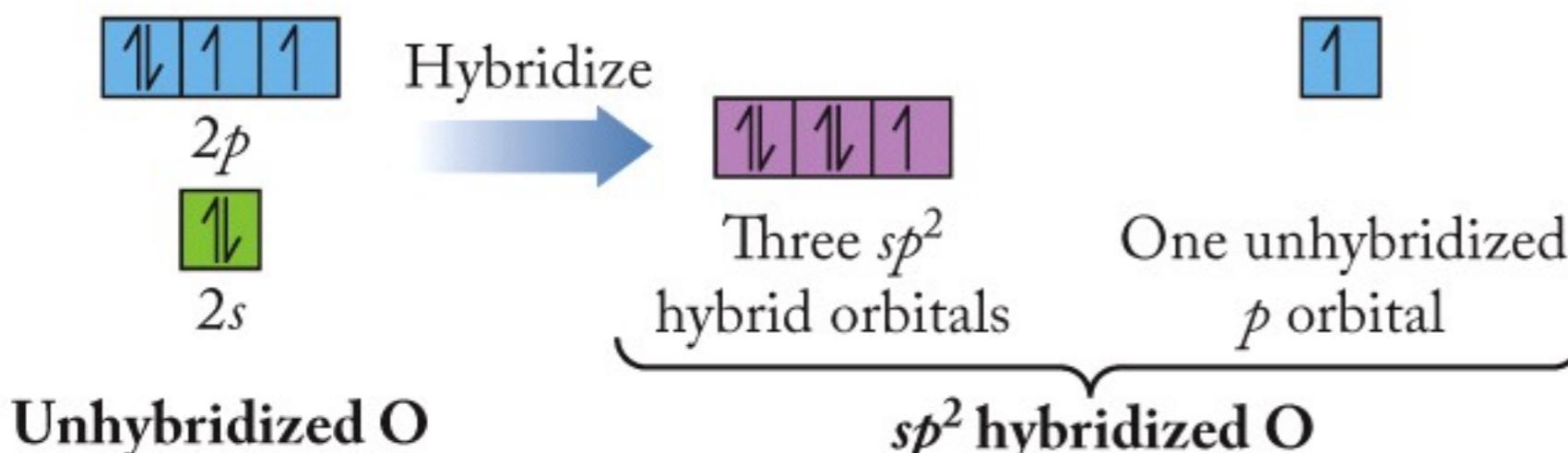
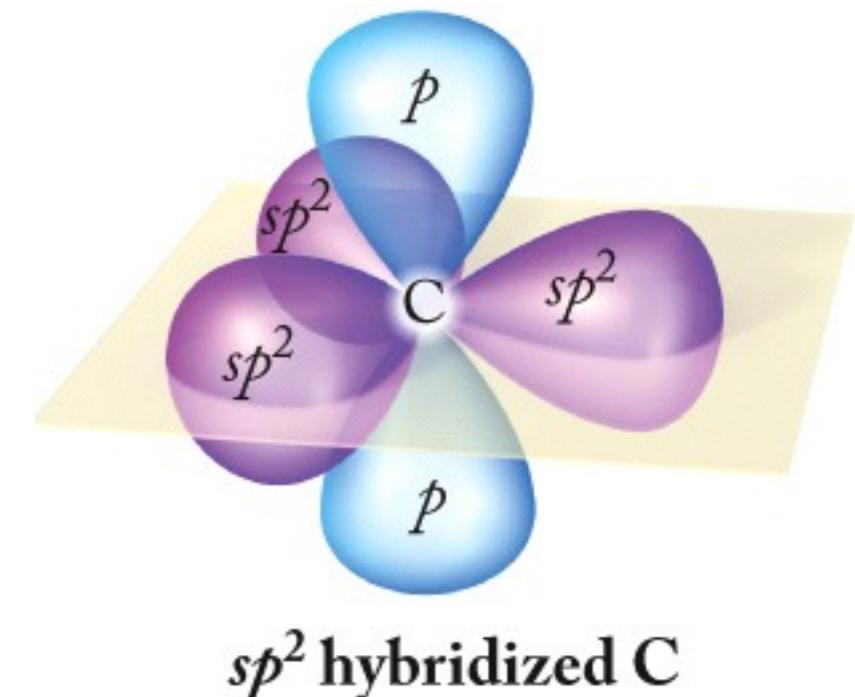
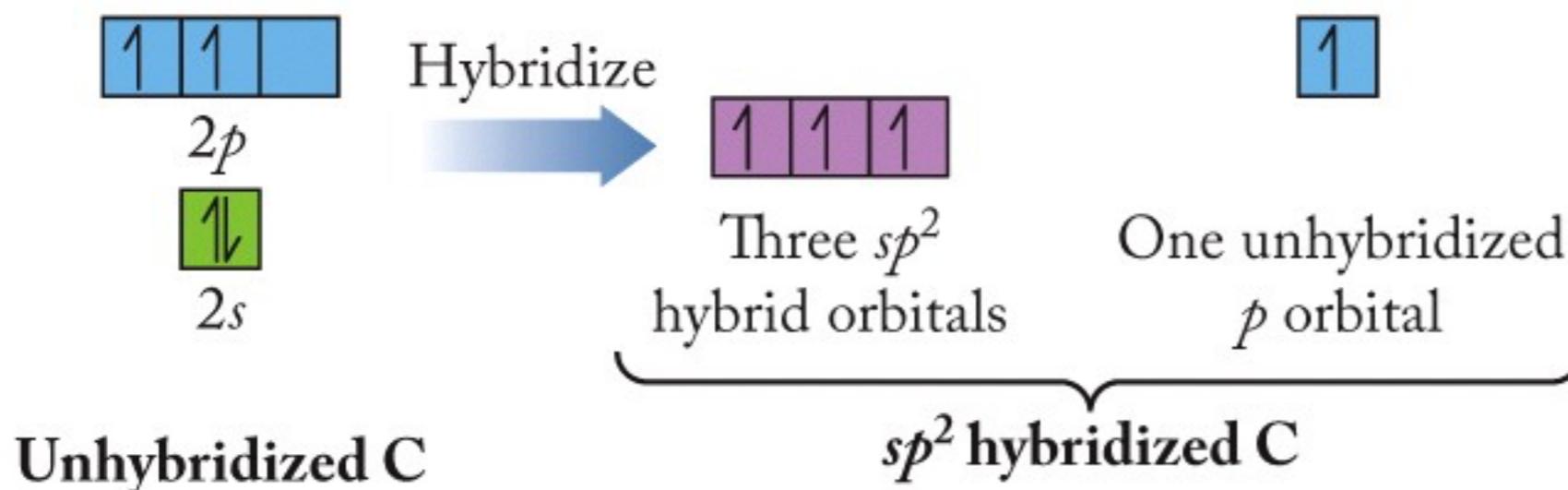
This is where the **tetrahedral** VSEPR structure comes from

Formation of sp^3 Hybrid Orbitals

Tro 6.3

One *s* orbital and three *p* orbitals combine to form four sp^3 orbitals.

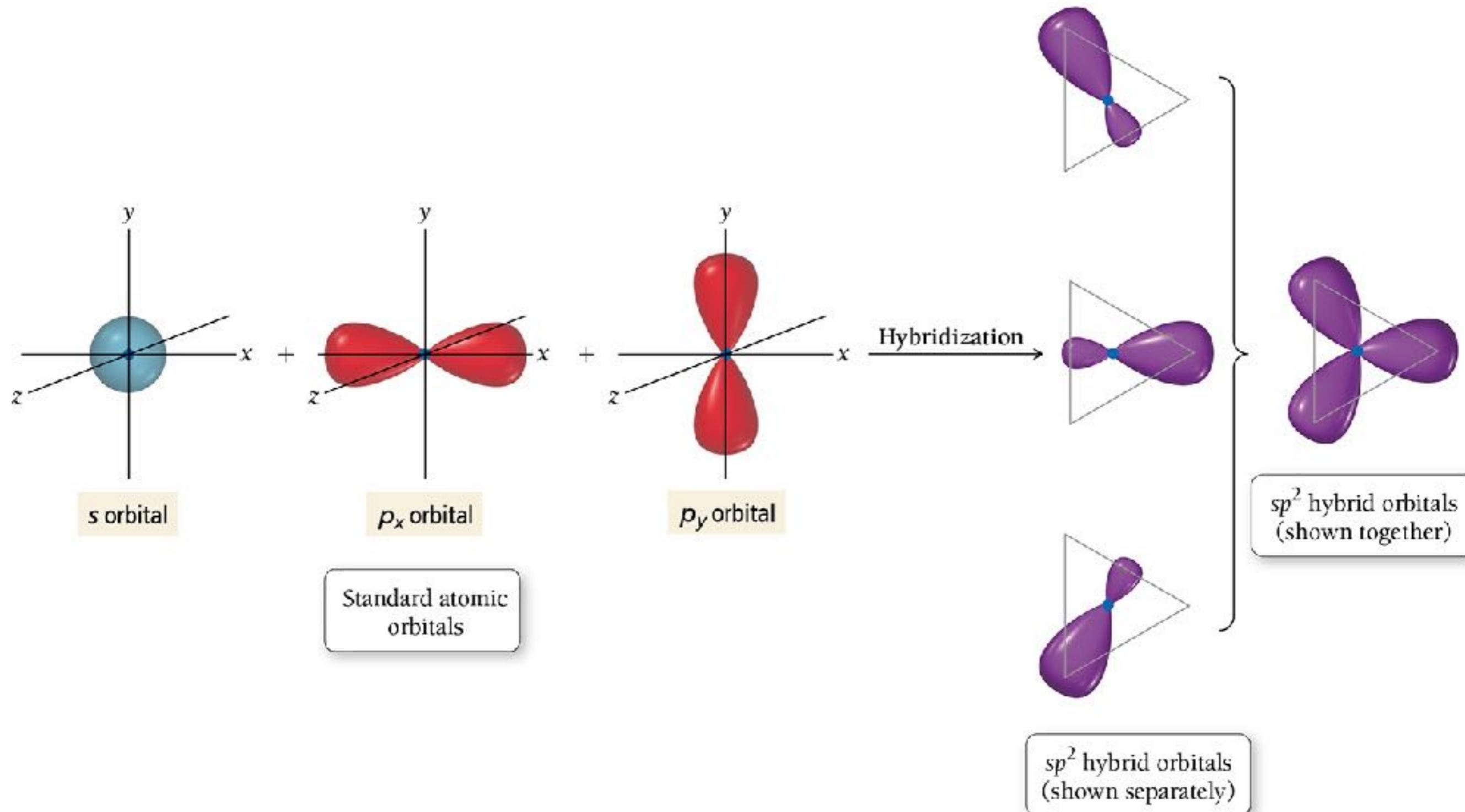




This is where the **trig. planar** VSEPR structure comes from

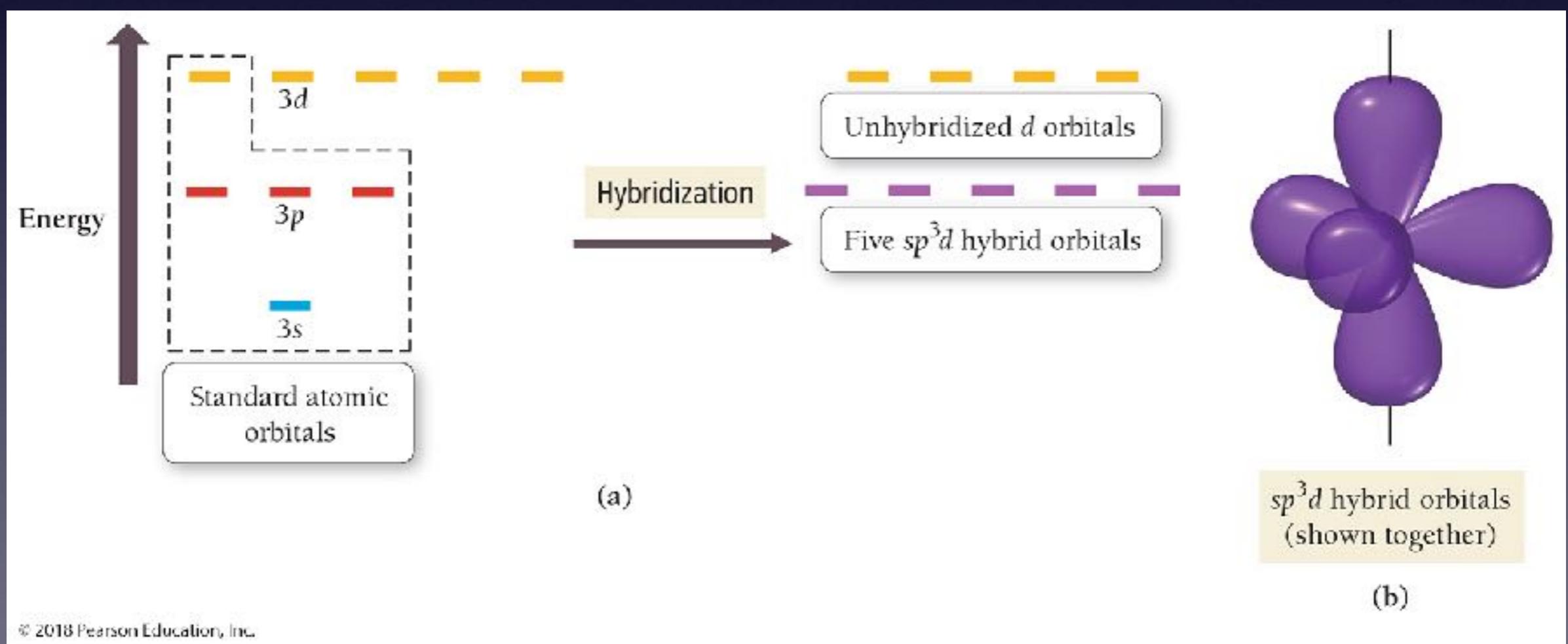
Formation of sp^2 Hybrid Orbitals

One *s* orbital and two *p* orbitals combine to form three sp^2 orbitals.



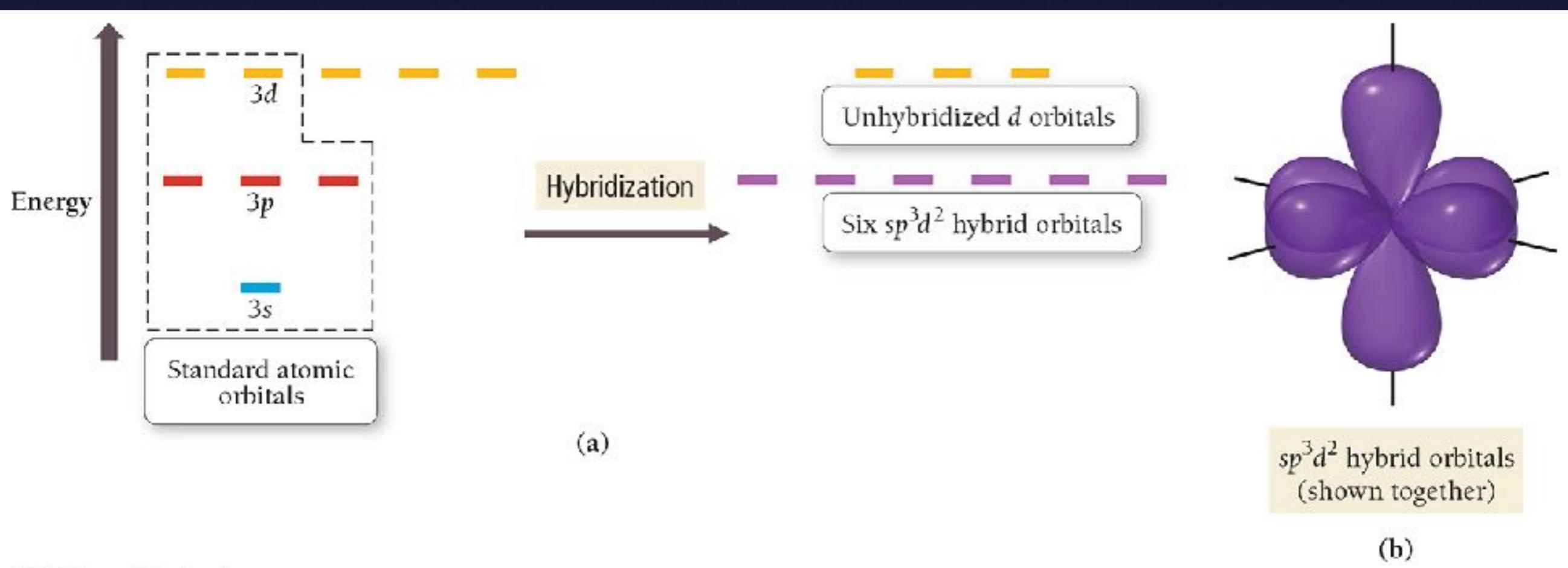
What you're also responsible for... (Hybrid schemes in expanded octets)

- sp^3d hybridization yields **trig. bipyrimidal** VSEPR structure



What you're also responsible for... (Hybrid schemes in expanded octets)

- sp^3d^2 hybridization yields **octahedral** VSEPR structure



Expectations for hybridization

- Can you...
 - ...identify the hybridization (if any) of a central atom or atoms
 - ...identify the sigma and pi bonds (if any) to that atom
 - ...draw sp , sp^2 , and sp^3 orbitals including nodes and phase?
 - ...draw sigma and pi bonds including nodes and phase?



Where did we go today?

Ch1010-A17-A03 Lecture 18

- § 6.2–6.3 Valence Bond Theory and Hybrid Orbitals

Next time...

- § 6.3 Finishing Hybrid Orbitals