

Valence Bond Theory and Hybridization

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Characterizing Chemical Bonding

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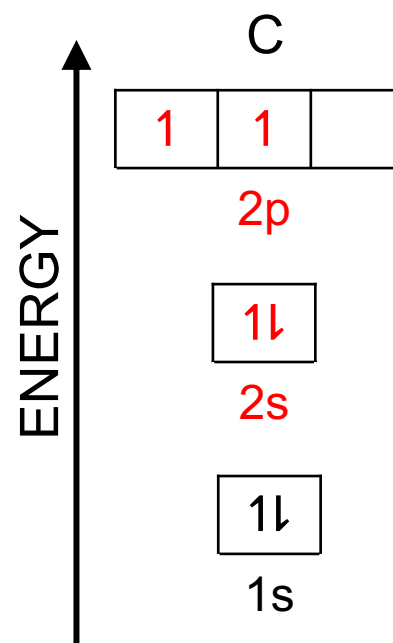
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In other words, C: $1s^2 2s^2 2p^2$

So we have 6 valence electrons, which we can use to form bonds.



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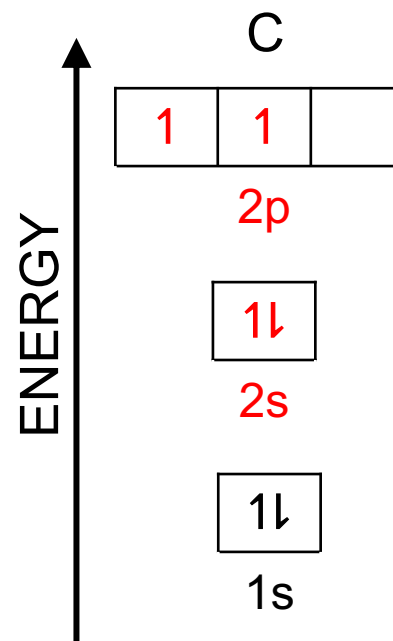
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What happens when we form a molecule like CH_4 ?



At the moment, C looks like it only has 2 electrons in the 2p orbital to bond with.

Yet, the 4 H atoms in CH_4 bring 4 extra electrons ($1s^1$).

How then can we make sense of these 4 bonds that do form?

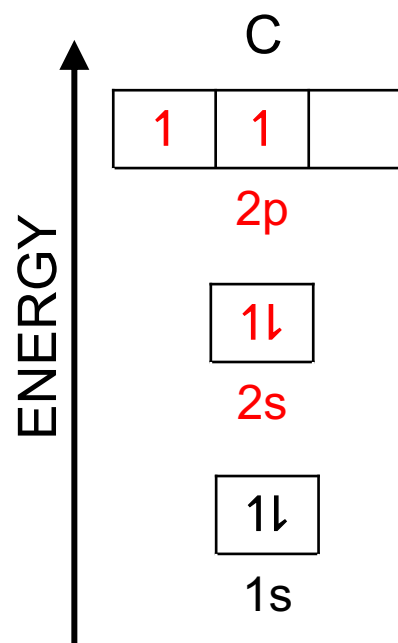
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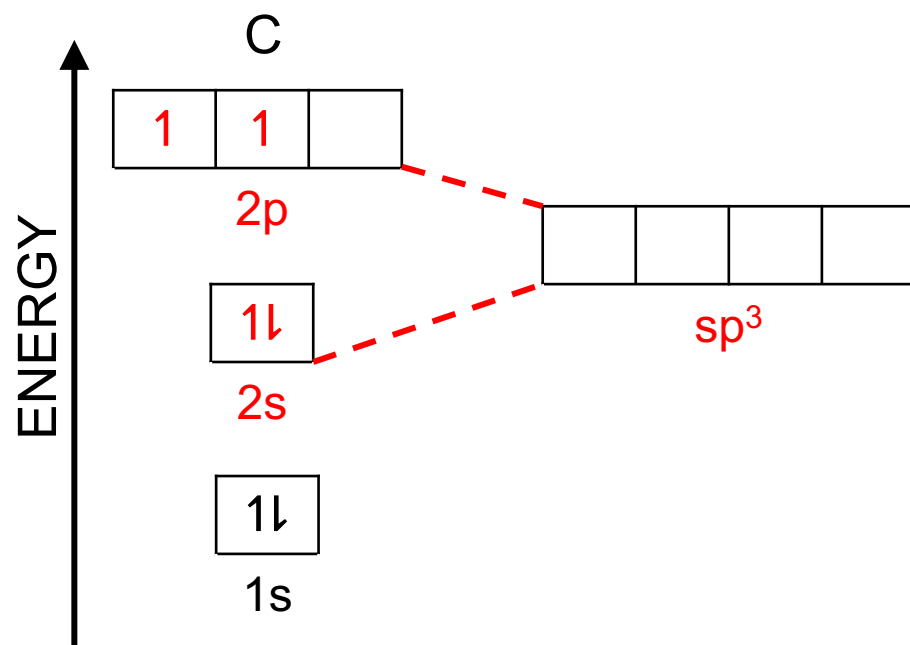
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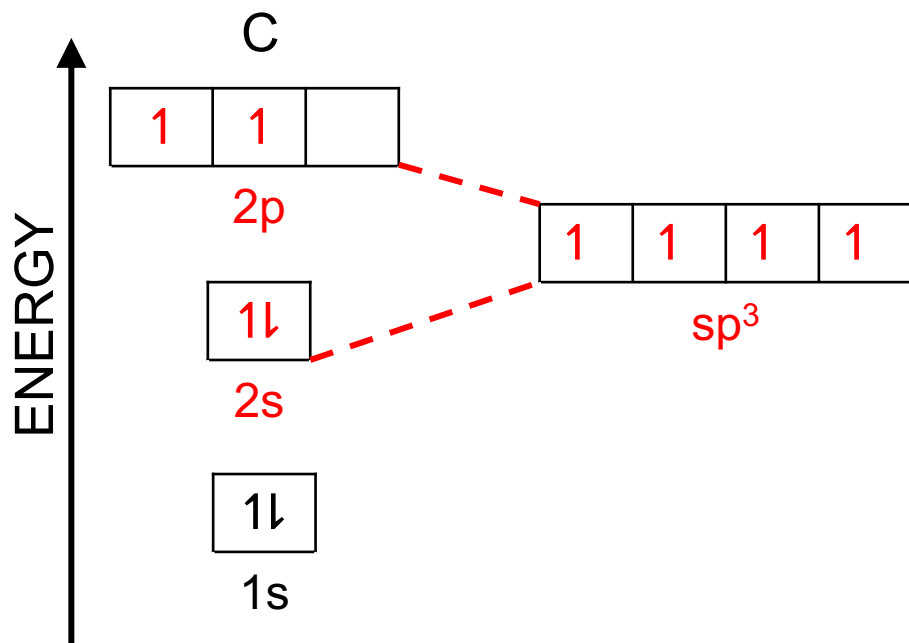


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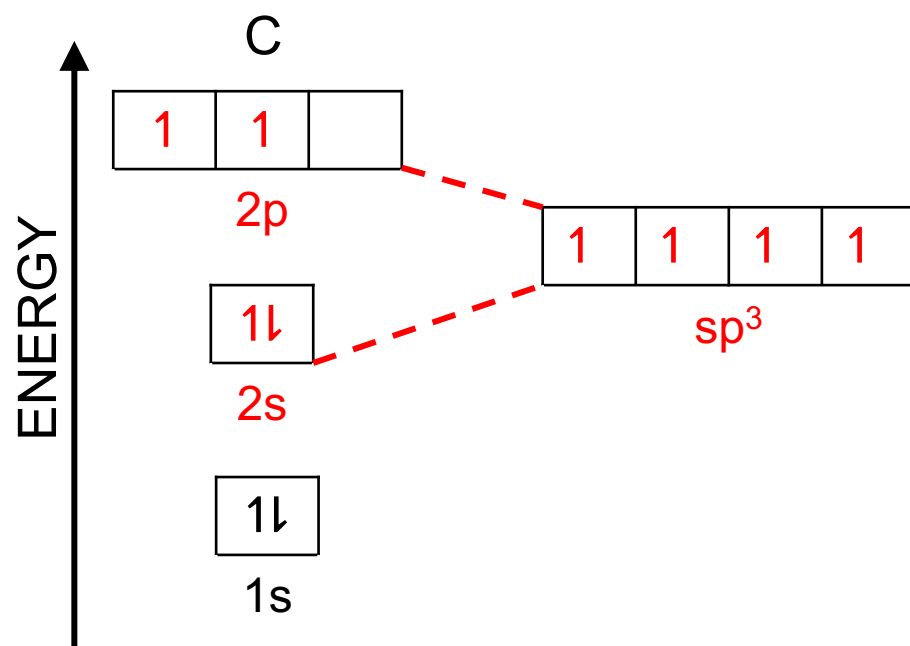
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Remember to fill in the hybrid orbitals like we normally do, fill 'up' across, then 'down'.

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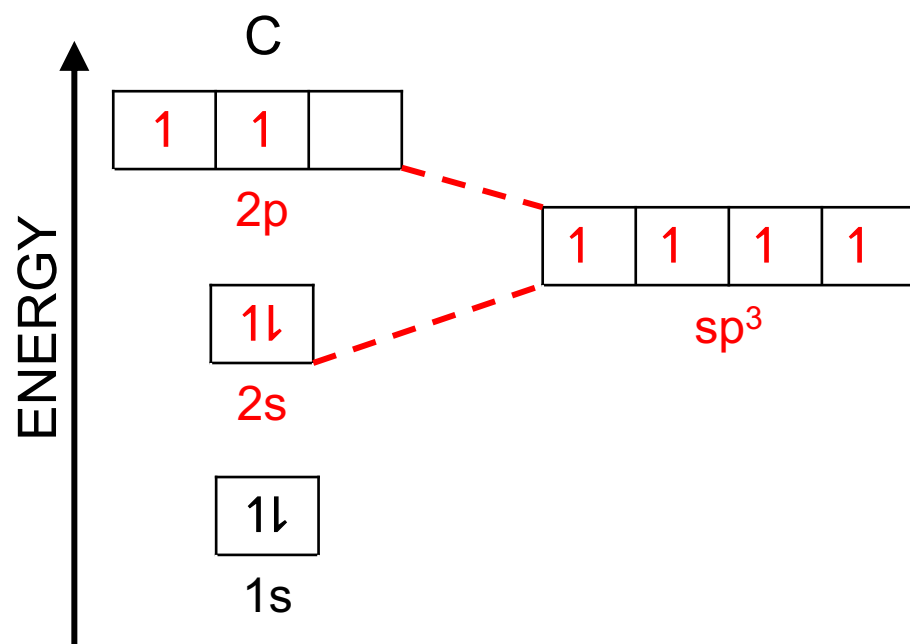


What do these four sp^3 orbitals look like?

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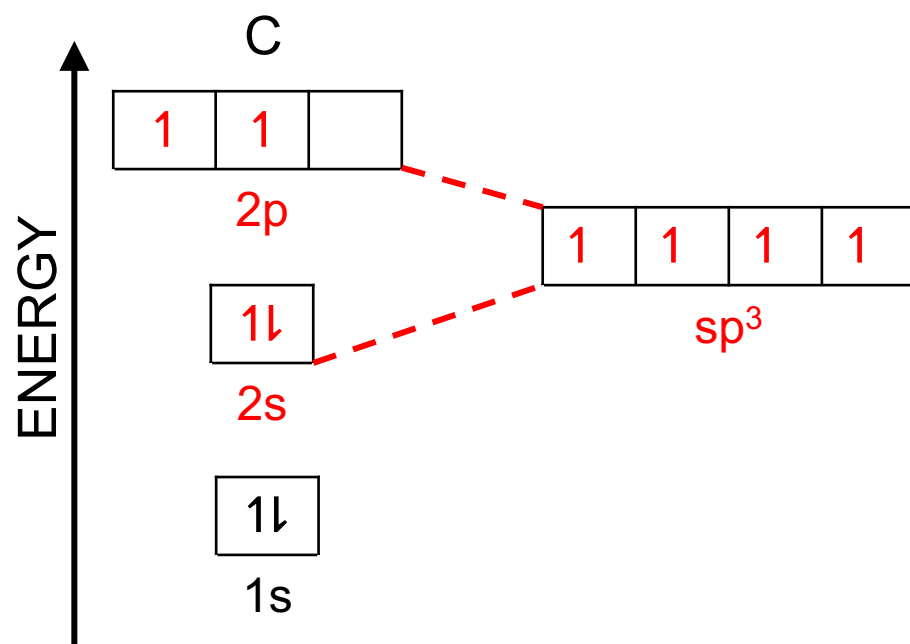
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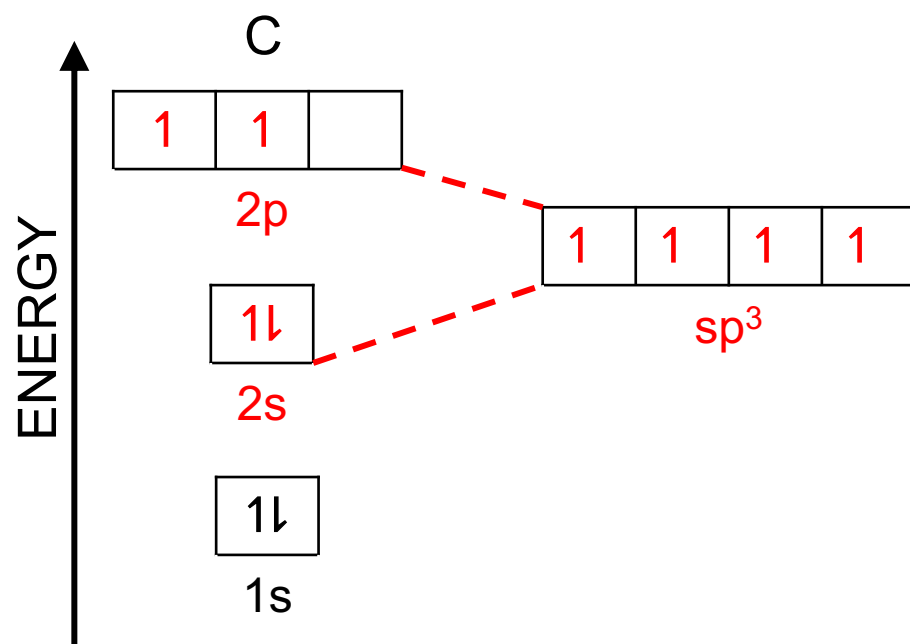
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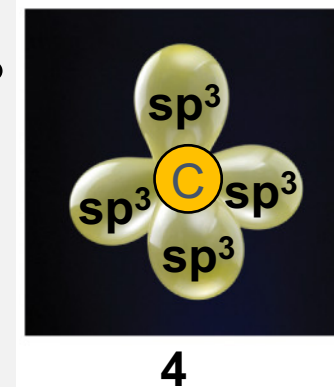


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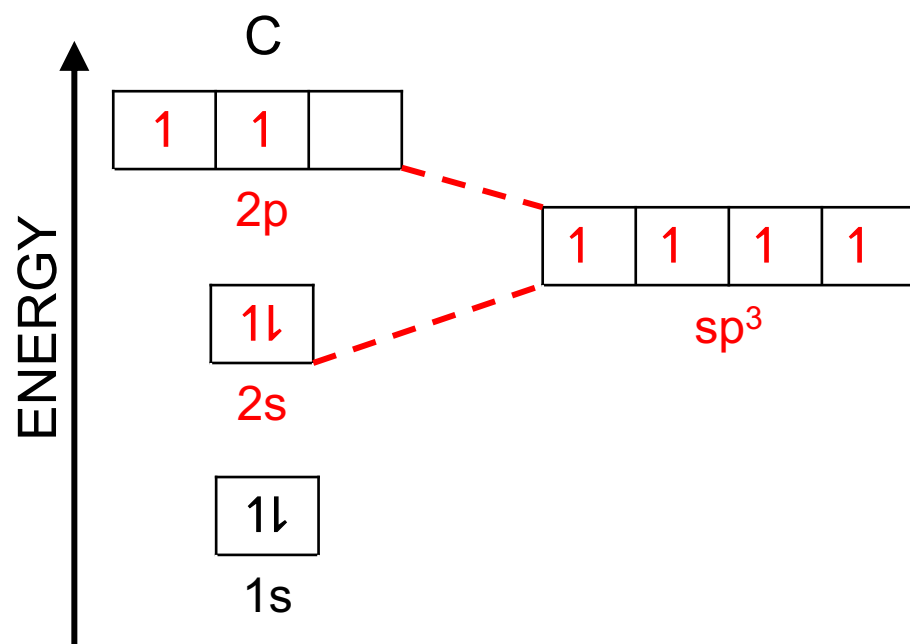
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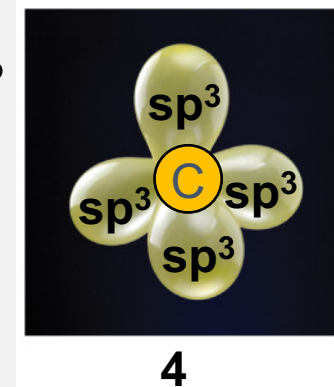
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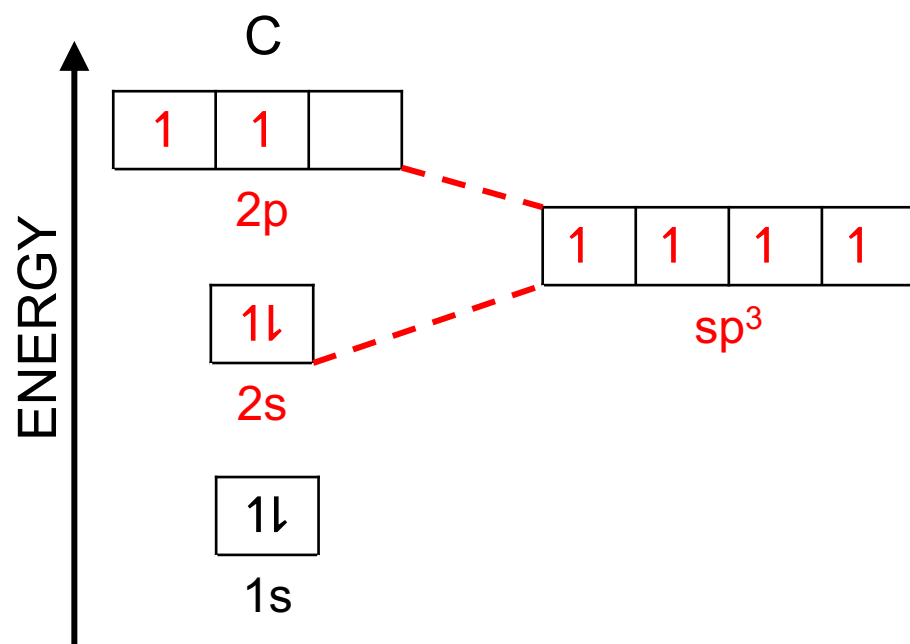
Valence bond helps us to understand these molecular geometries.



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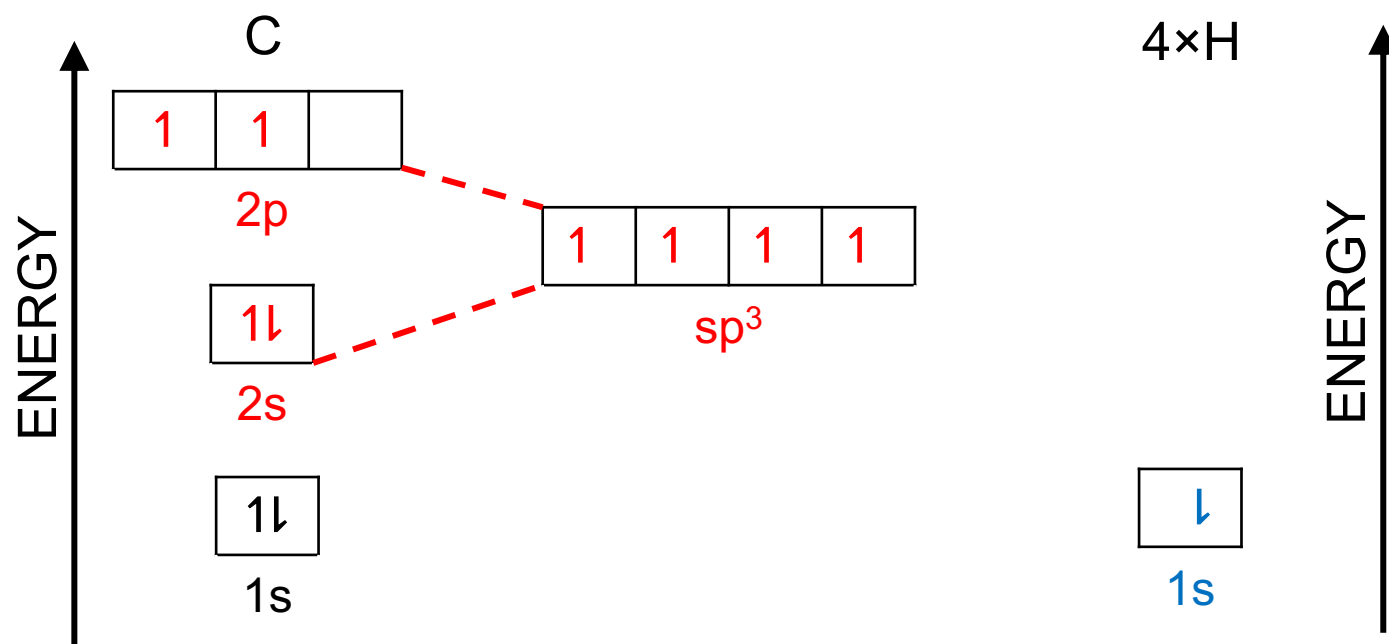


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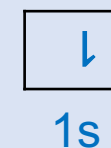
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What do the 4 H atoms bring to the table?

Each brings one electron:



Types of Hybridized Orbitals

Find the SN of the central atom → Determine hybridization [# of hybrid orbitals = # of mixed orbitals]

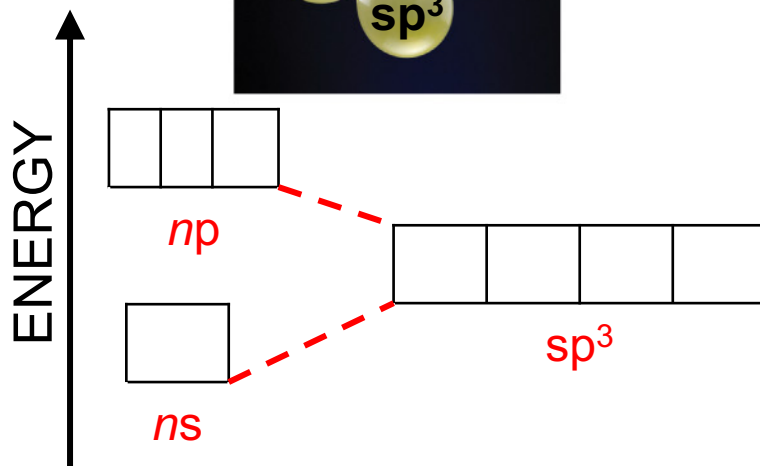
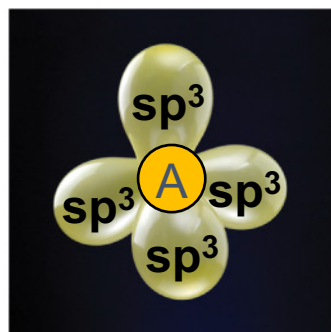
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$$4 sp^3 = 1 s + 3 p$$

(can only form σ bonds)



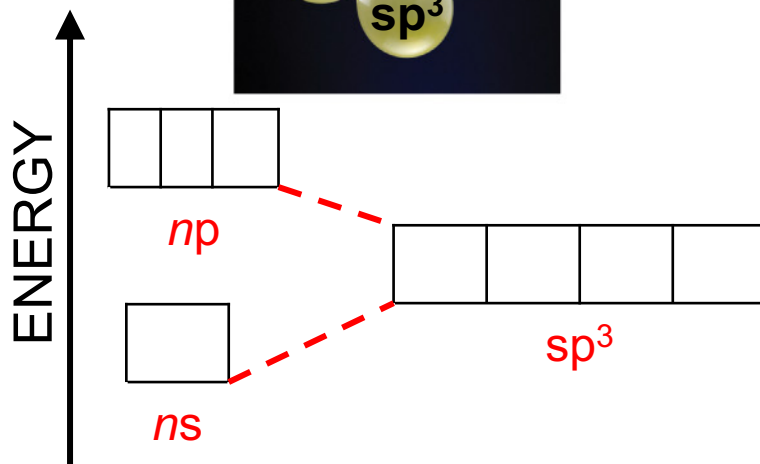
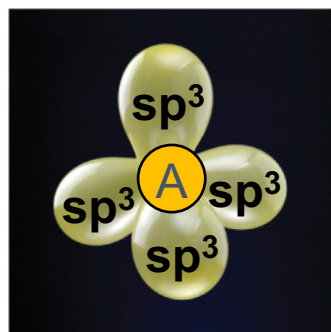
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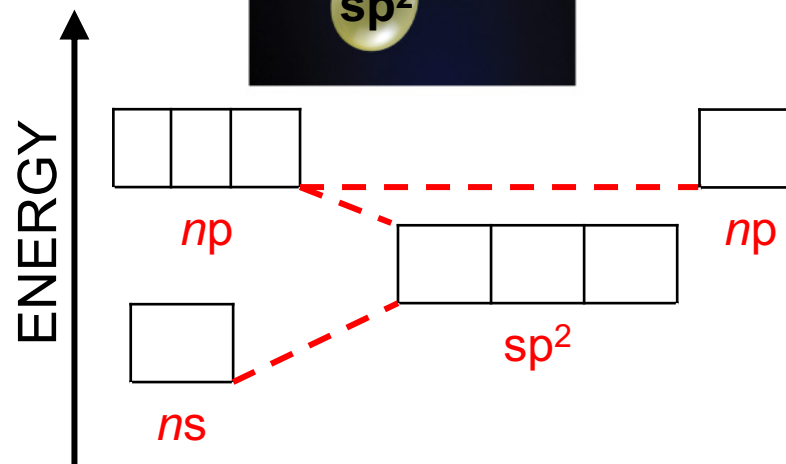
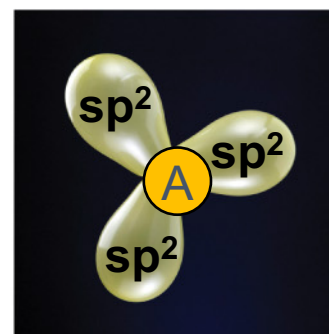


SN = 3 → sp^2 hybridization

$$3 sp^2 = 1 s + 2 p$$

(1 unhybridized p)

(can form σ and 1 π bond)



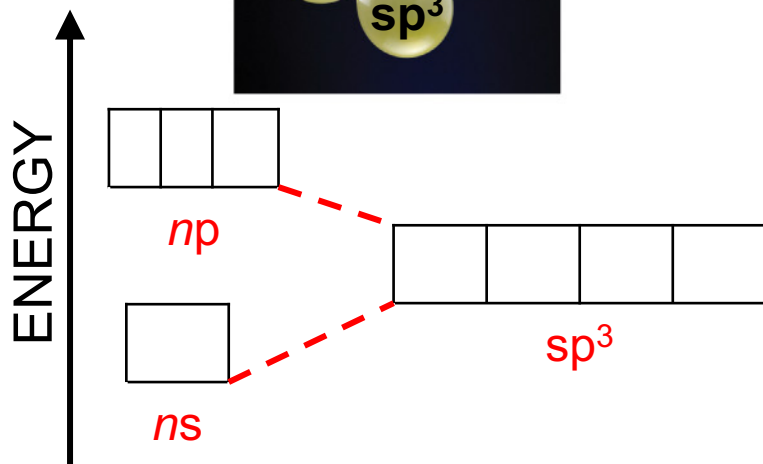
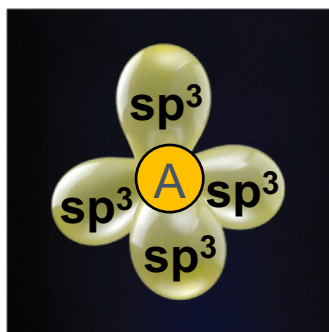
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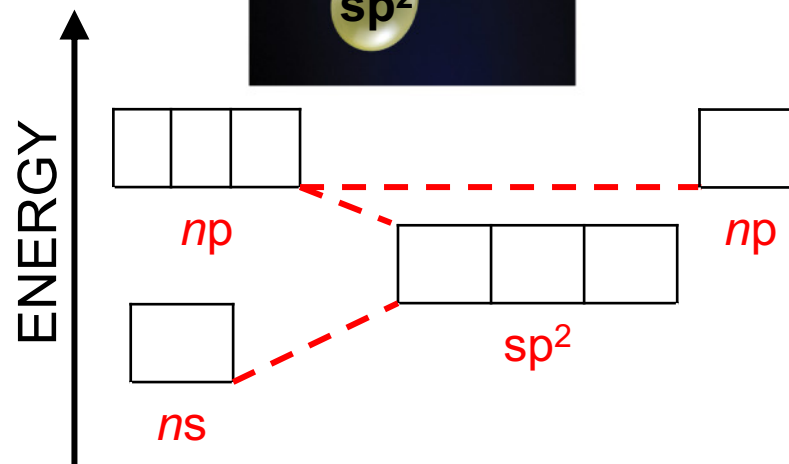
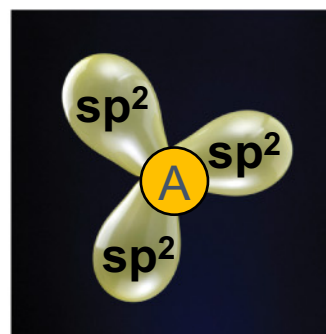


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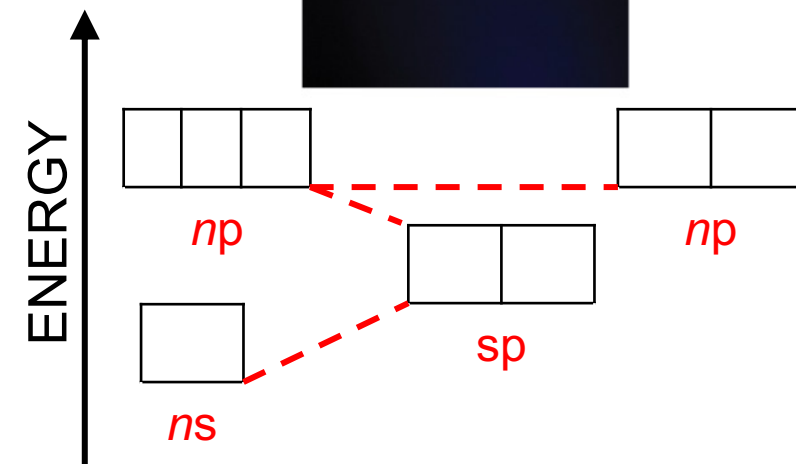
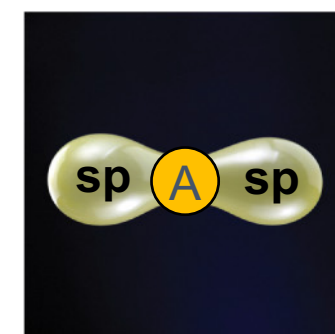


SN = 2 → sp hybridization

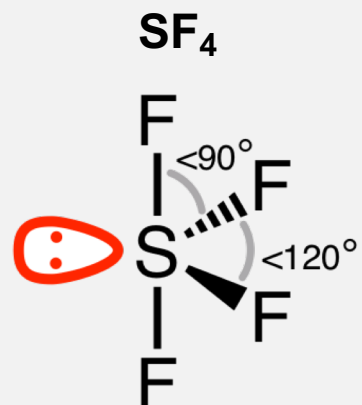
$$2 sp = 1 s + 1 p$$

(2 unhybridized p)

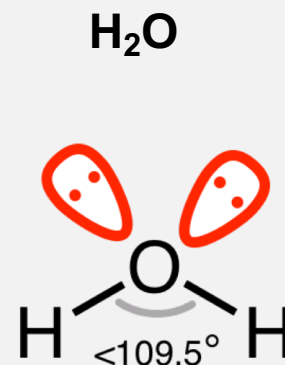
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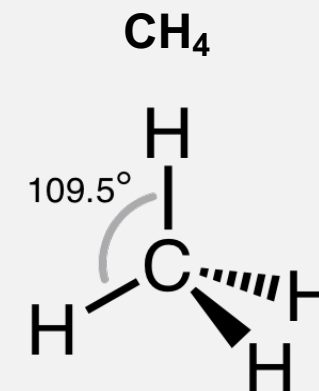
Determine the hybridization for each of the following central atoms.



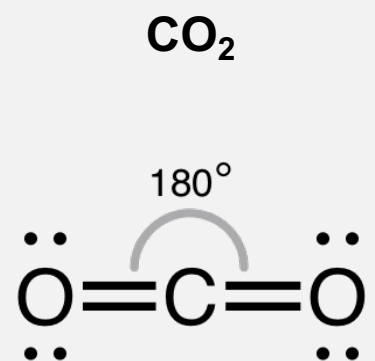
SN = 5, see-saw



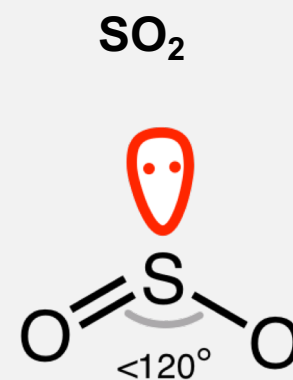
SN = 4, bent



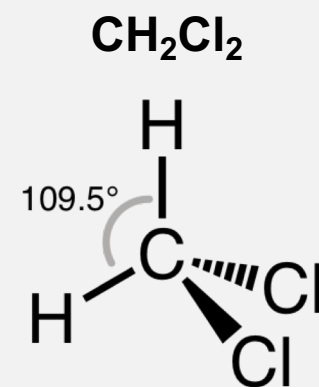
SN = 4, tetrahedral



SN = 2, linear

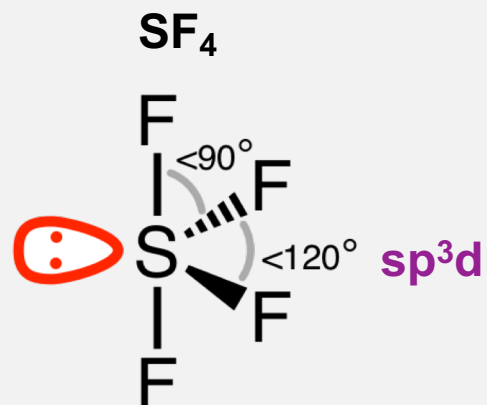


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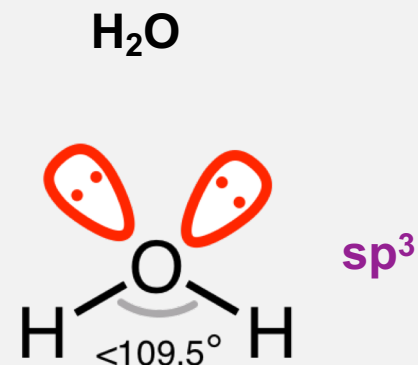


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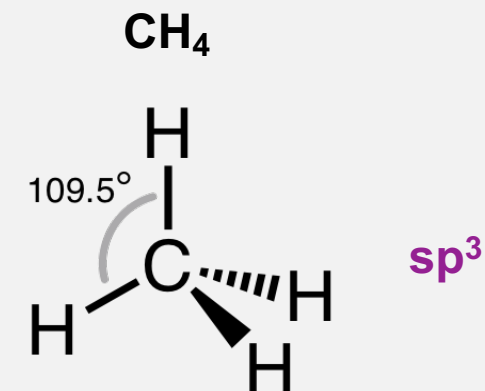
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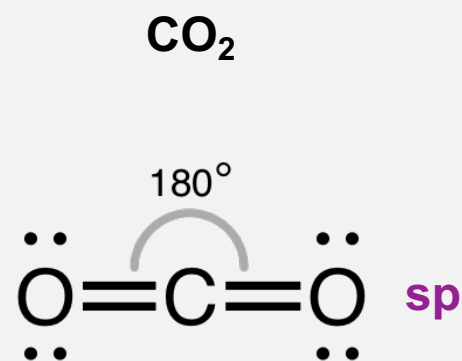
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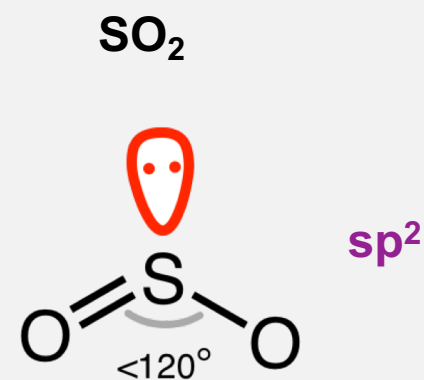
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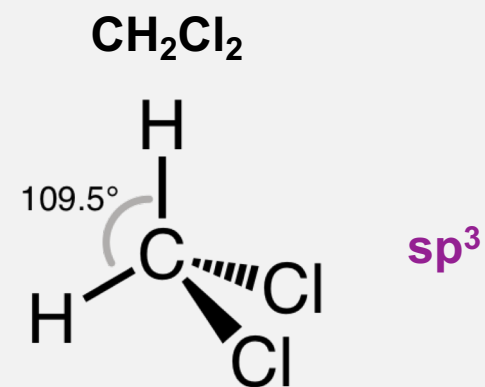
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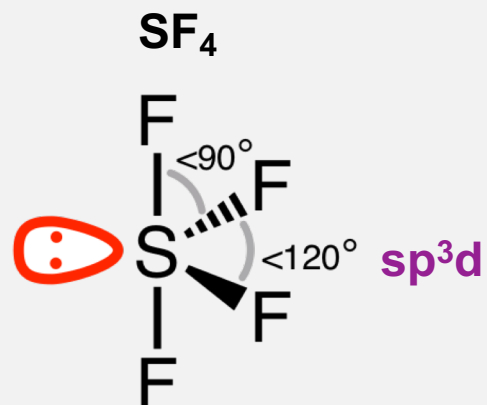


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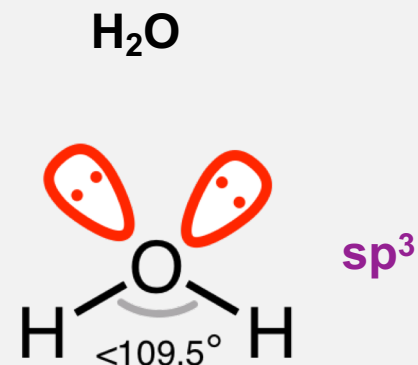


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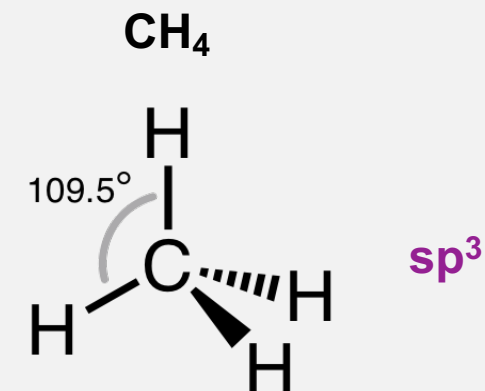
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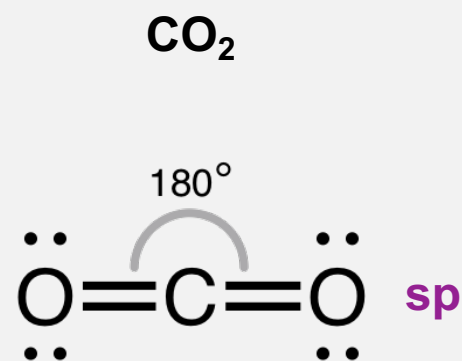
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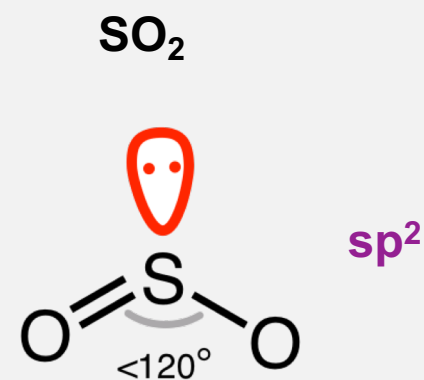
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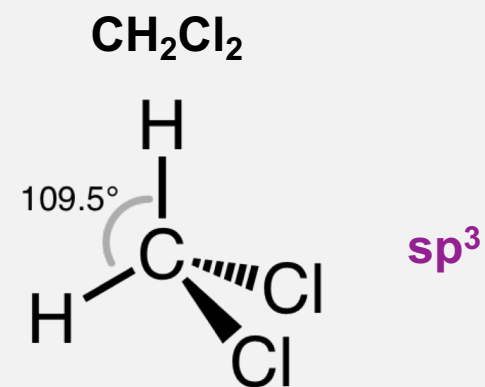
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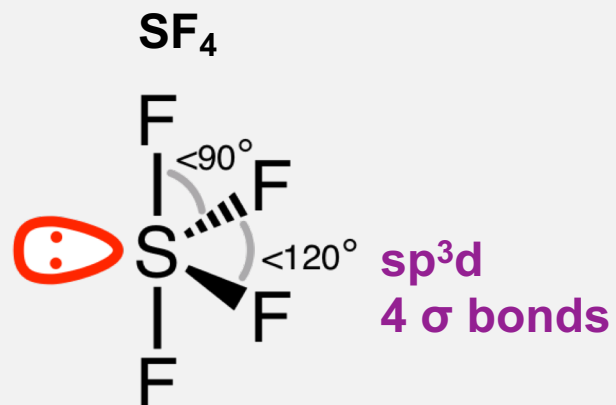


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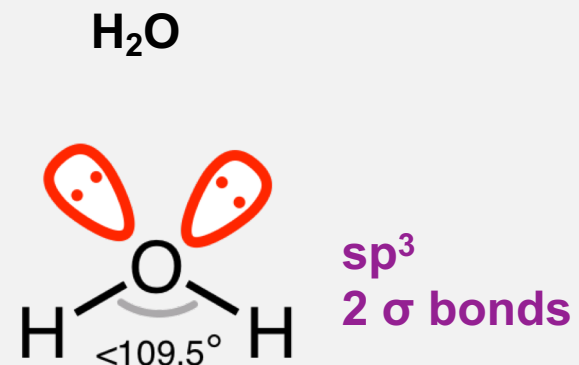


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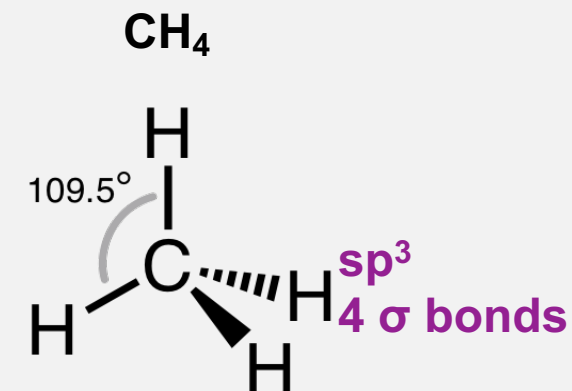
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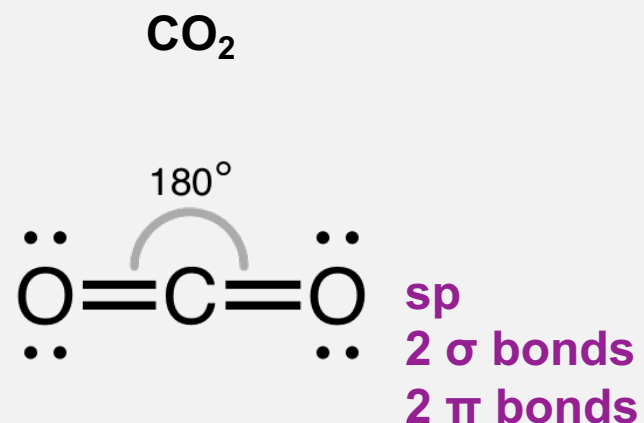
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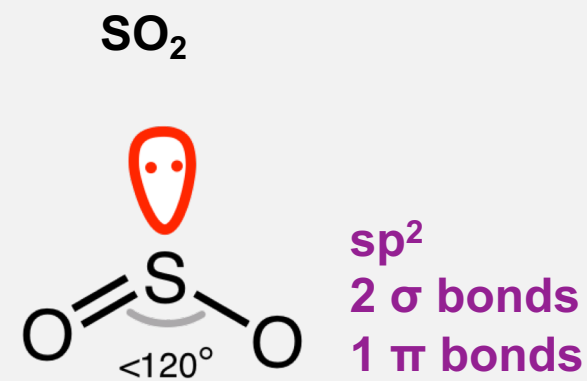
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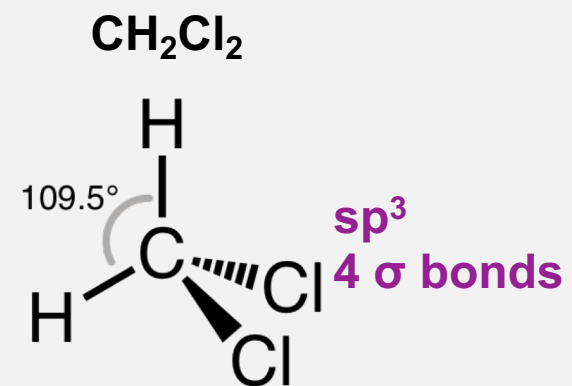
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