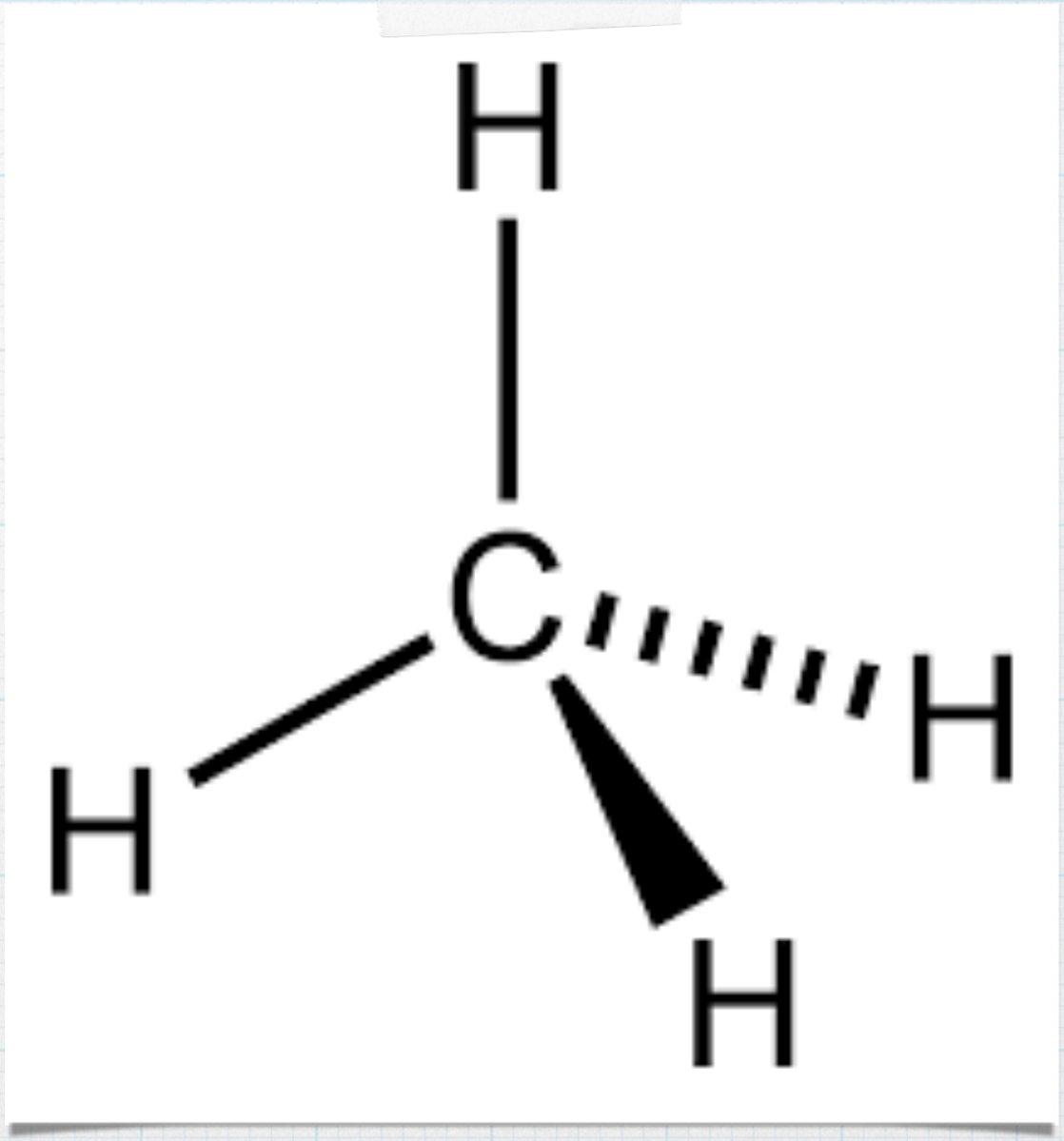
Hybridization

Hybridization

* The central atom's single bonds must be identical in a molecule
* Sometimes this requires the central atom's orbitals to combine and form new hybrid orbitals.

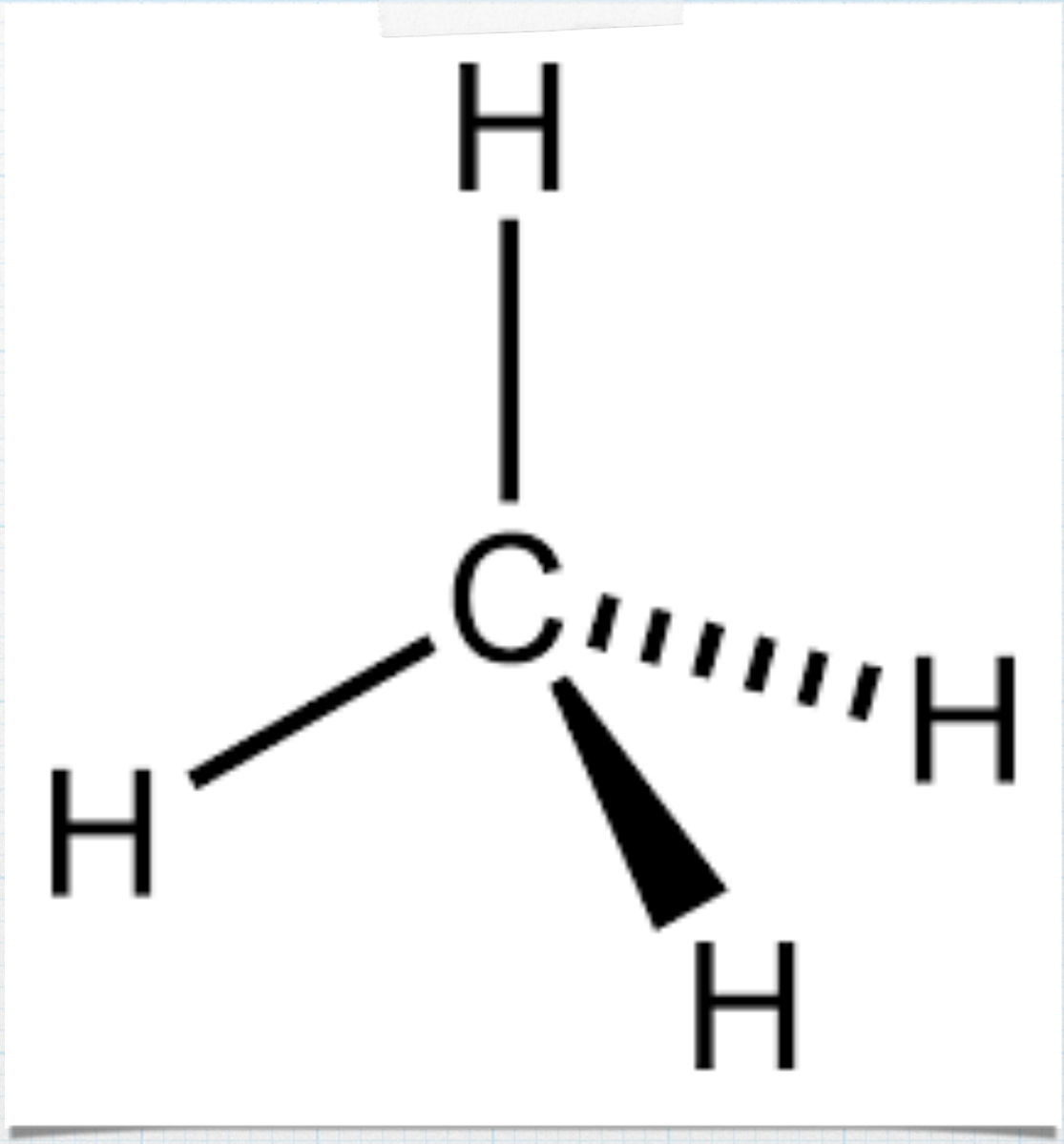
Example

* Methane:
  * central atom is carbon and it is bonded to 4 surrounding hydrogen atoms



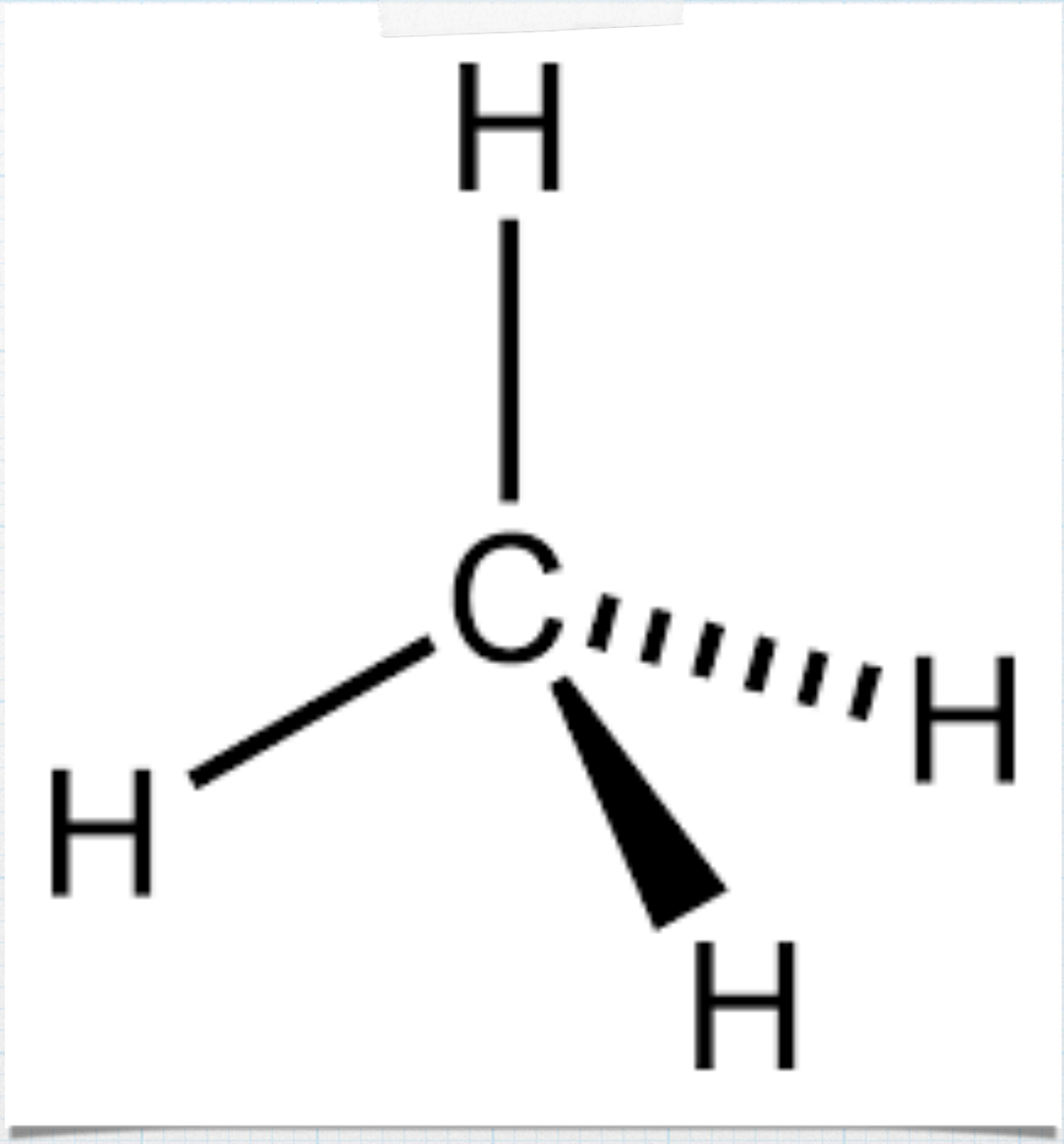
Example

* The electron configuration carbon $1s^2 2s^2 2p^2$.
* In order to form 4 bonds, the last 4 electrons must be in alone in their orbitals.



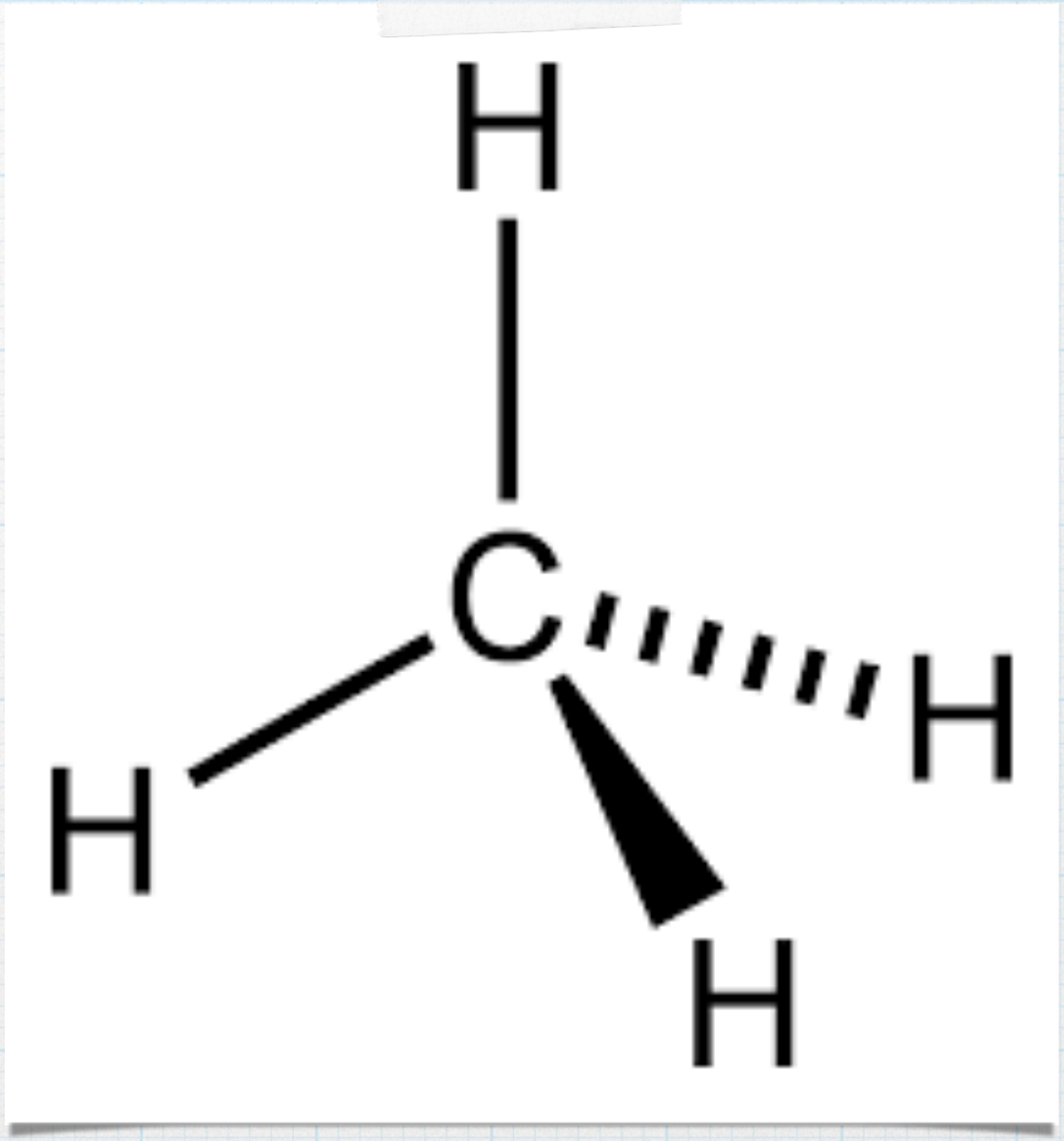
Example

* You can re-write the electron configuration as $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$



Example

* There is one s electron and there are three p electrons. These orbitals will combine and be called sp^3 orbitals



Try it . . .

* Consider $AlCl_3$, what type of hybrid orbital would you find?

Try it . . .

* Consider $AlCl_3$, what type of hybrid orbital would you find?
  * Aluminum has three valence electrons

Try it . . .

* Consider $AlCl_3$, what type of hybrid orbital would you find?
    * Aluminum has three valence electrons
    * It's electron configuration would be $[Ne]3s^23p^1$

Try it . . .

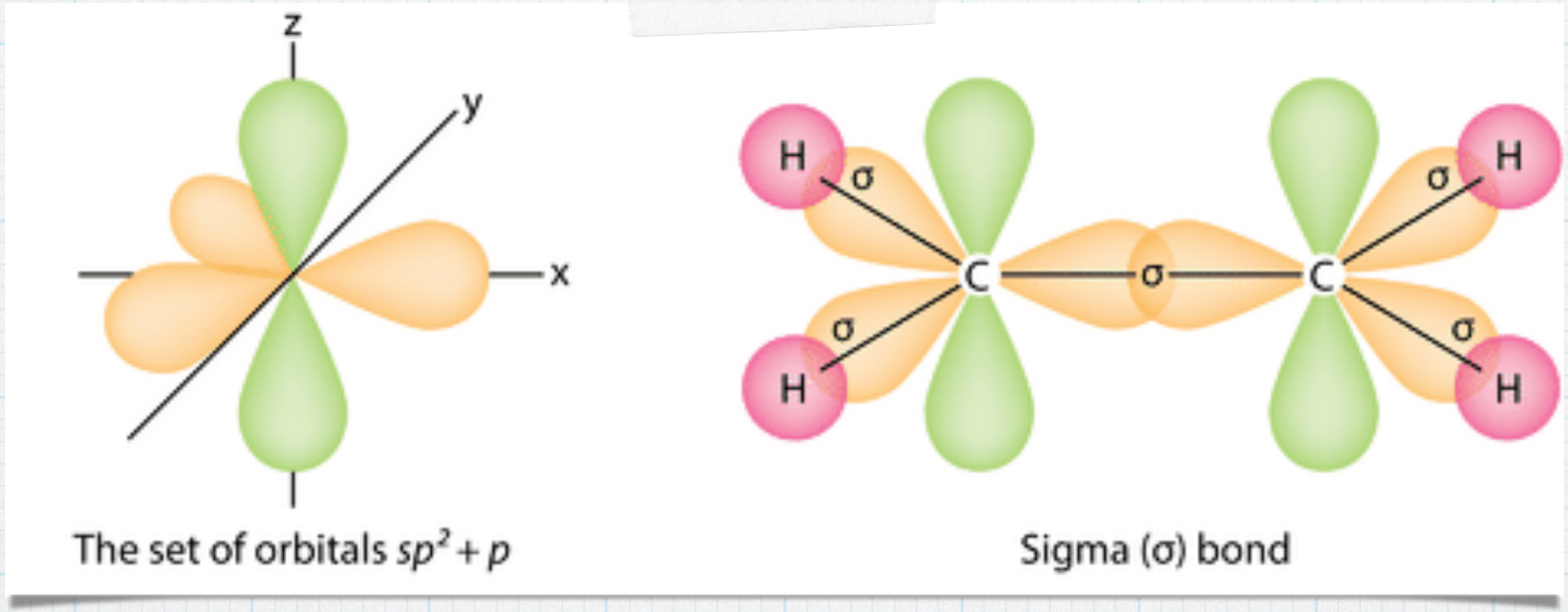
* Consider $AlCl_3$, what type of hybrid orbital would you find?
  * Aluminum has three valence electrons
  * It's electron configuration would be $[Ne]3s^2 3p^1$
  * This can be combined as $3sp^2$

Try it . . .

* Consider $AlCl_3$, what type of hybrid orbital would you find?
    * Aluminum has three valence electrons
    * It's electron configuration would be $[Ne]3s^2 3p^1$
    * This would hybridize as $[Ne]3s^1 3p^1 3p^1$
    * This can be combined as $3sp^2$

Bonding

Sigma (σ) Bonds

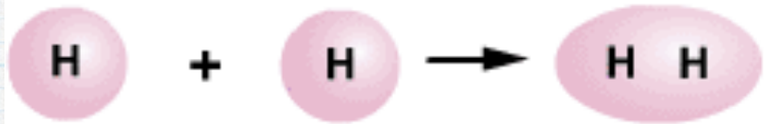


The set of orbitals $sp^2 + p$ — Sigma (σ) bond

* A sigma bond is defined as a bond that is symmetrical around the bond axis of the two nuclei

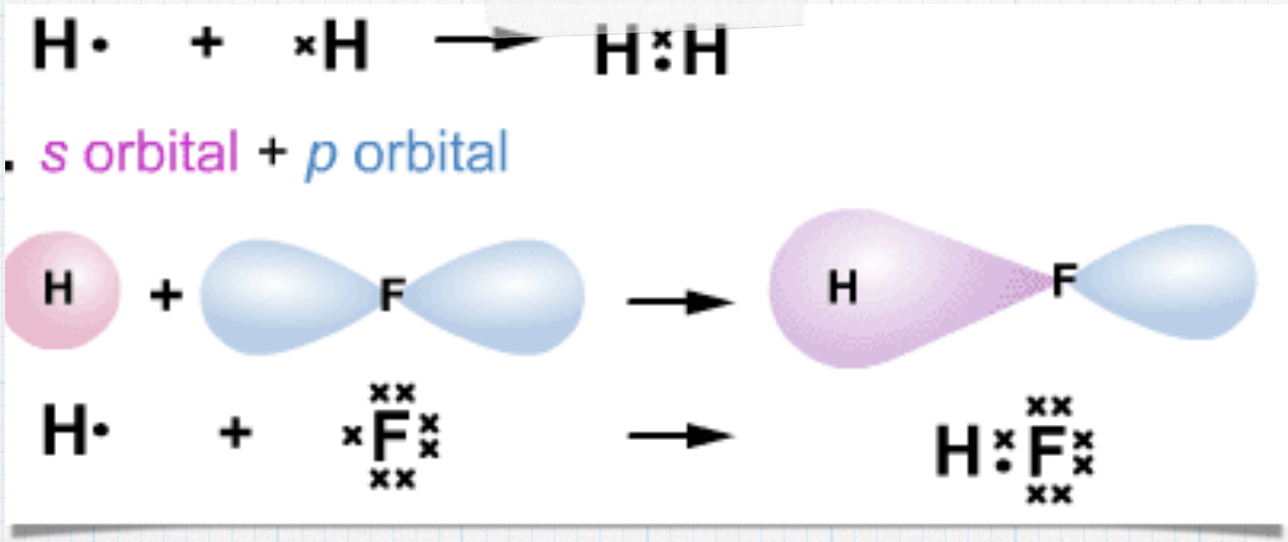
Sigma (σ) Bonds

. *s* orbital + *s* orbital



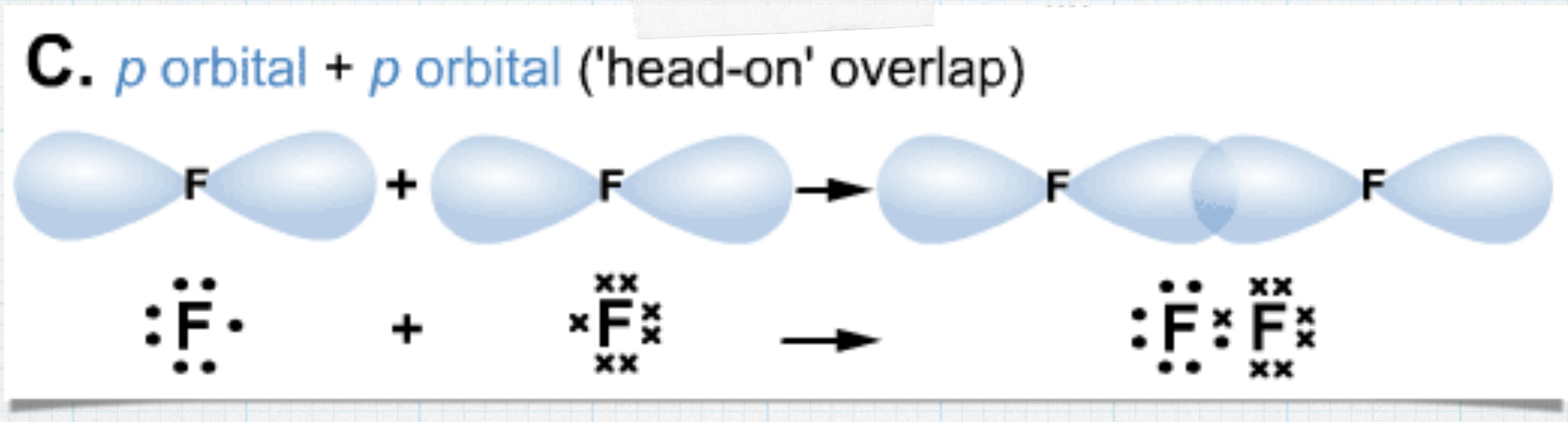
* Example: H_2
  * Each hydrogen has as electron in an s orbital, when this s orbitals overlap, a bond is formed.
  * The sigma bond has a lower energy level than other individual s orbital, making it more stable.

Sigma (σ) Bonds



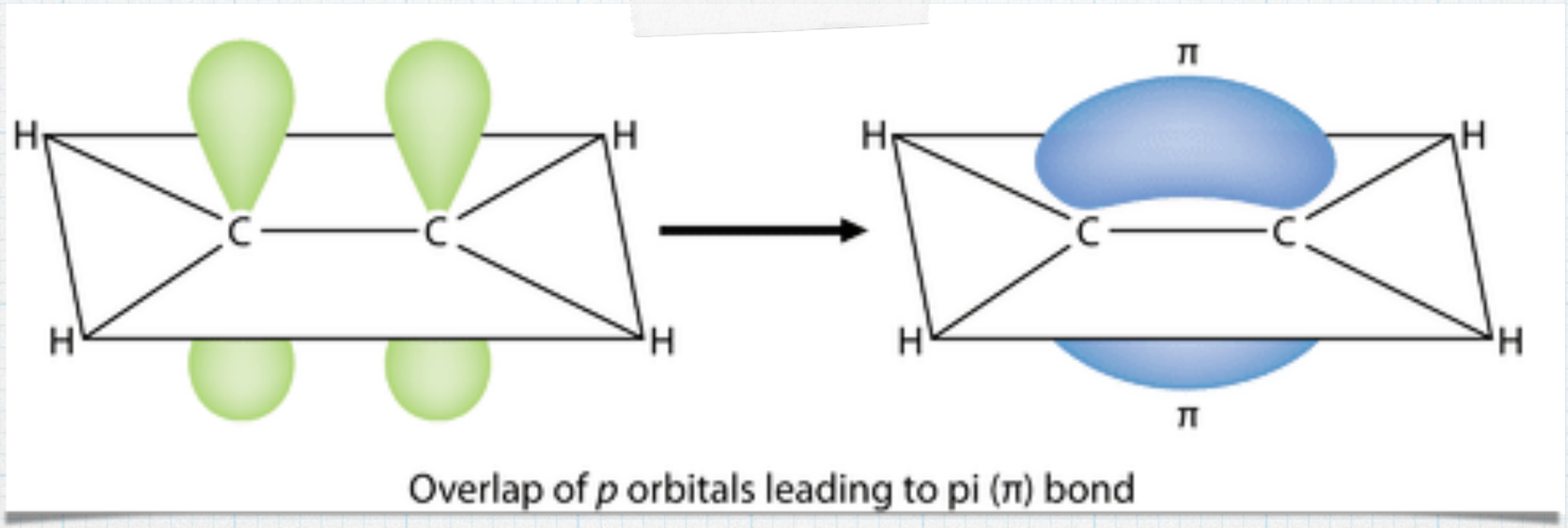
- Example: HF
  - Hydrogen has a half filled s and fluorine has a half filled p. The two overlap to form a sigma bond.

Sigma (σ) Bonds



* Example: F_2
  * Each F has a half filled p orbital. They overlap to form a sigma bond.

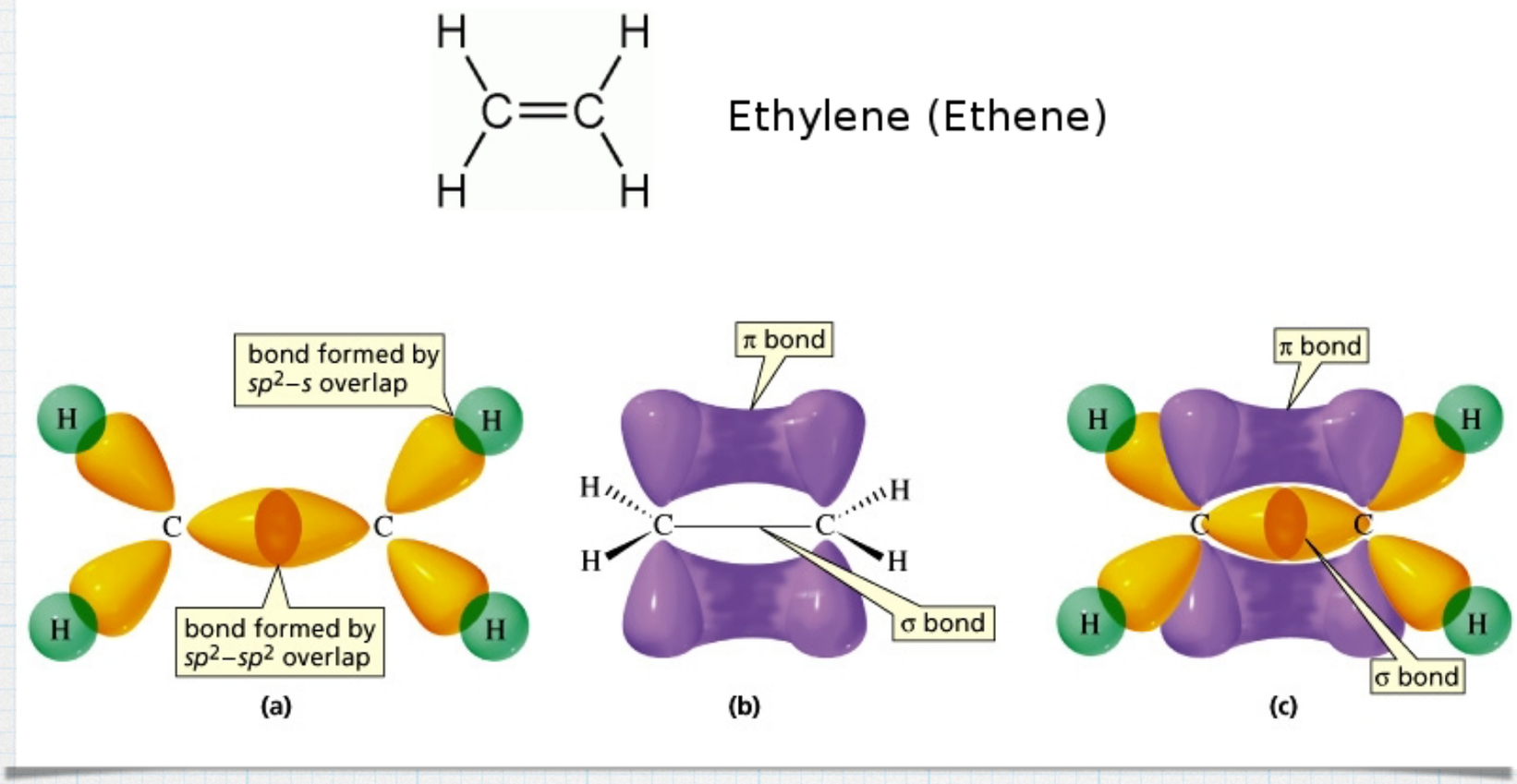
Pi (π) Bonds



Overlap of *p* orbitals leading to pi (π) bond

* A pi bond is formed by sideways or lateral overlapping orbitals

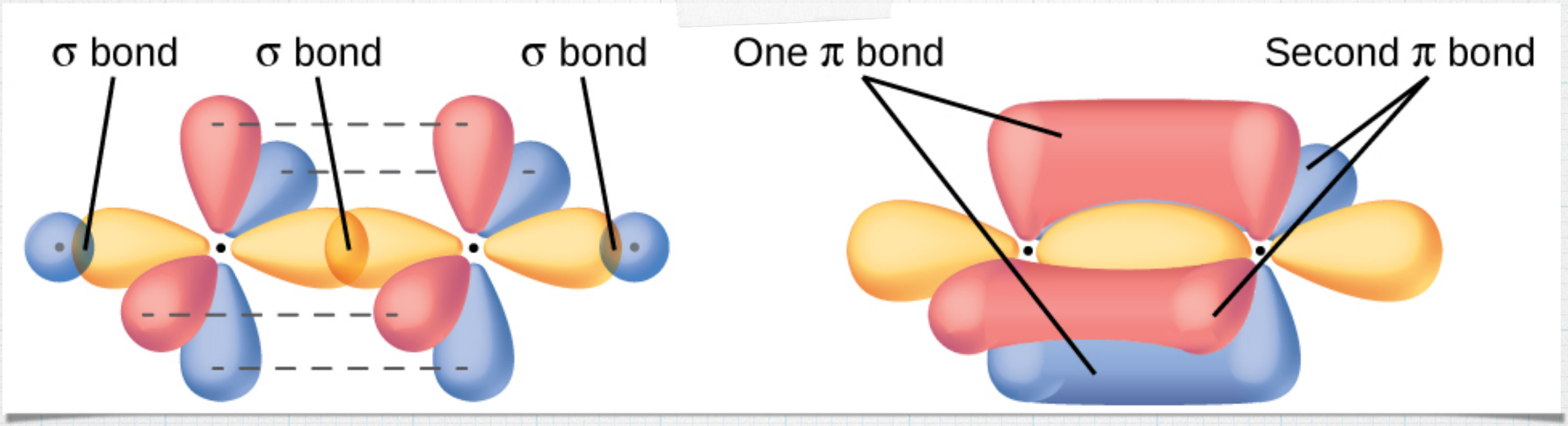
Example



* In ethene ($H_2C=CH_2$), the first bond formed between carbons is a sigma bond (end to end overlap)

* The second bond formed between carbons is a pi bond (sideways overlap)

Example



* Ethyne (HC=CH), there is one sigma and two pi bonds