AP Chemistry Unit 2 - Bonding - Hybridization Handout

Hybridization

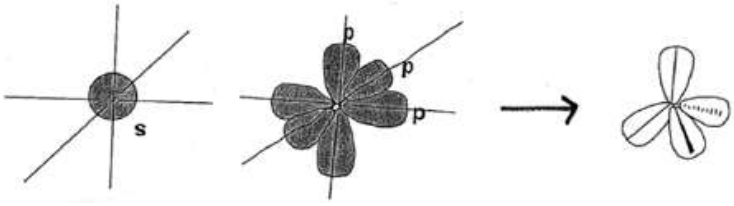
- Mixing of atomic orbitals to make new "hybrid" orbitals of new energy and shape suitable for chemical bonding.
- Concept of mixing atomic orbitals into new hybrid orbital's (with different energies shapes, etc than original atomic orbitals)
- Useful in explaining molecular geometry

- Hybrid bonding
  - σ bond (sigma)
    - single bond
    - free rotation characterized by head on overlap
    - also part of double and triple bonds

  - π bond
    - double/triple bonds
    - no rotation
    - can only with empty p orbitals

Single bond – sigma
Double bond – sigma, pi
Triple bond – sigma, pi, pi

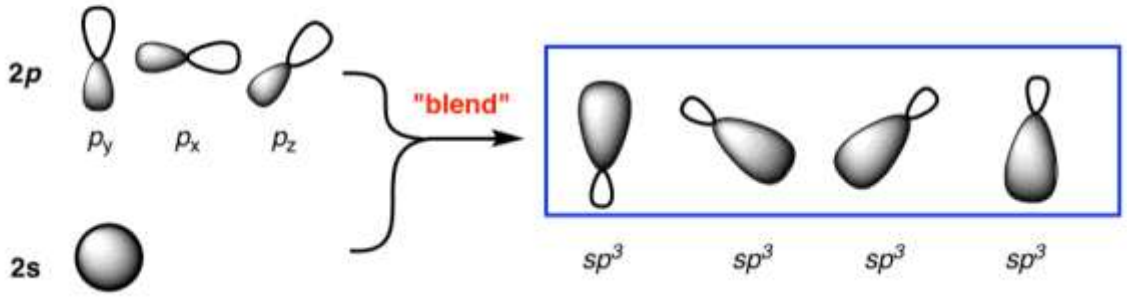
- To create 4 areas around a central atom you need to utilize 4 orbitals (think valence)



1 s orbital used 3 p orbitals used 4 sp^3 orbitals

One answer to the question: **sp^3 "Hybrid" Orbitals**

Three 2p orbitals and a single 2s orbital "hybridize" (blend) to make four identical sp^3 "hybrid" orbitals



4 unhybridized orbitals ($2s$, $2p_x$, $2p_y$, $2p_z$)

Three higher-energy *2p* orbitals and one lower-energy *2s* orbital

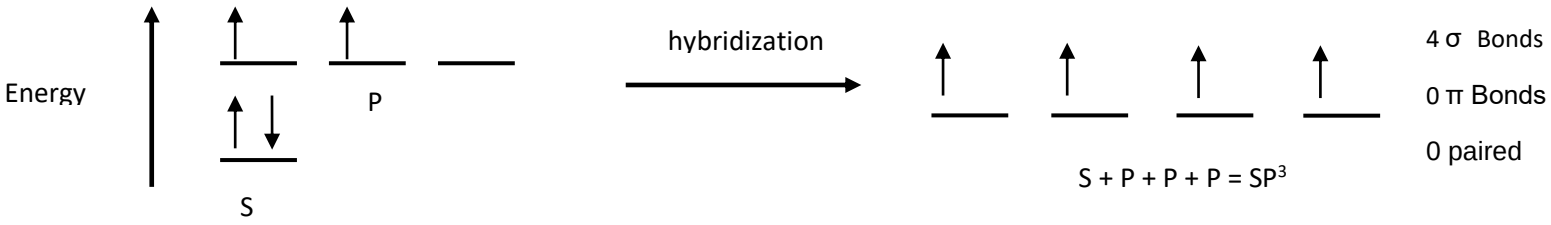
Linus Pauling "The Nature of The Chemical Bond" (1931)

4 hybridized sp^3 orbitals

Four sp^3 hybrid orbitals of identical energy which each have 25% *s* character and 75% *p* character

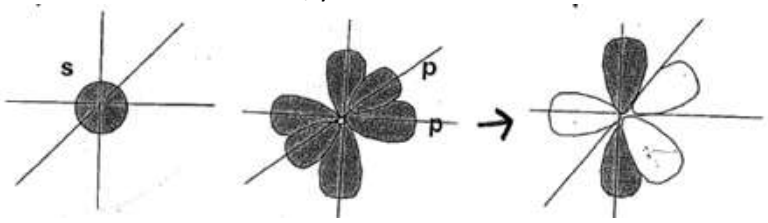
Oriented at 109.5° relative to each other

Example Carbon



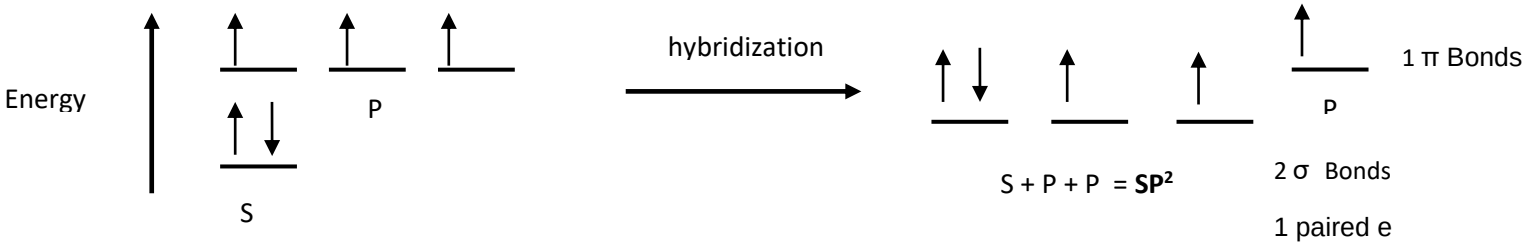
- Produces 4 singly occupied orbitals
- The energy released by the formation of 2 additional bonds more than compensates for the excitation energy required, energetically favoring the formation of 4 C-H bonds

- To create 3 areas around a central atom, you need to utilize 3 orbitals

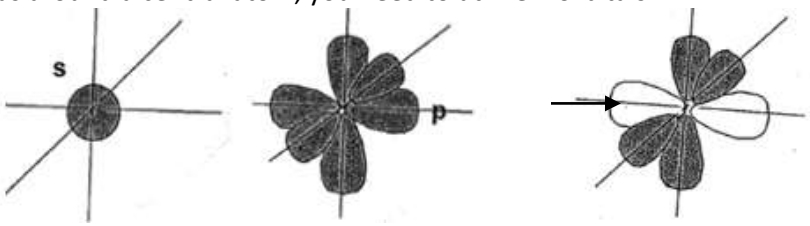


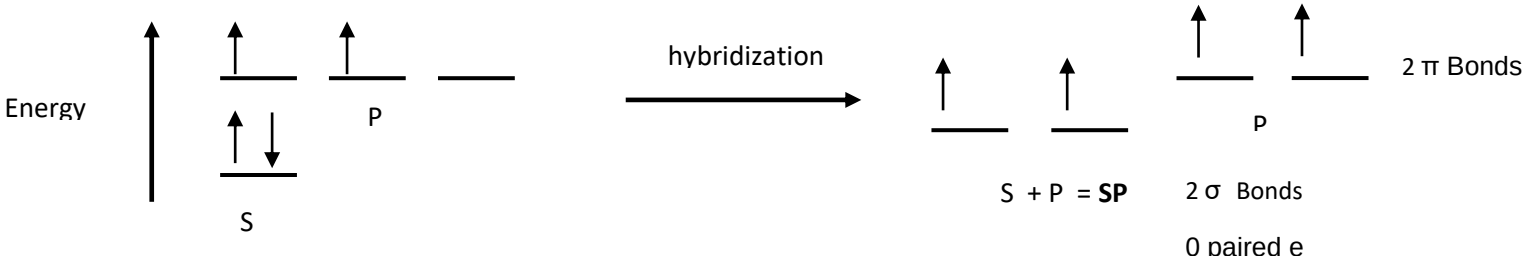
1 s orbital used 2 of 3 p's orbitals 1 p orbital unchanged
3 sp^2 orbitals

Example SP^2 - using N



- To create 2 areas around a central atom, you need to utilize 2 orbitals



1 s orbital used 1 of 3 p's orbitals 2 p orbitals unchanged
2 sp orbitals

Example SP - using C