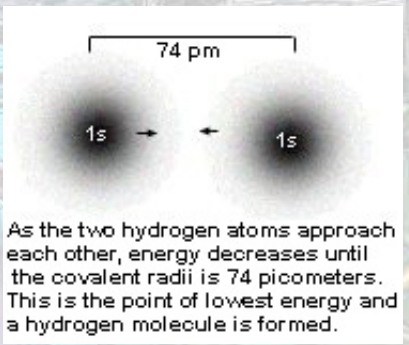
Hybrid Orbitals

Diagrams from http://library.thinkquest.org/15567

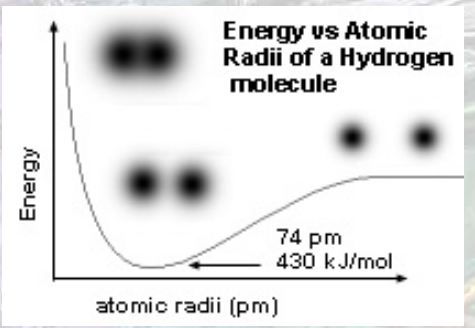
➢Why do atoms bond? It's a matter of energy. Nature always moves towards lowest energy. If bonding brings atoms to a lower energy state, the bond will form. See diagrams below.



As the two hydrogen atoms approach each other, energy decreases until the covalent radii is 74 picometers. This is the point of lowest energy and a hydrogen molecule is formed.

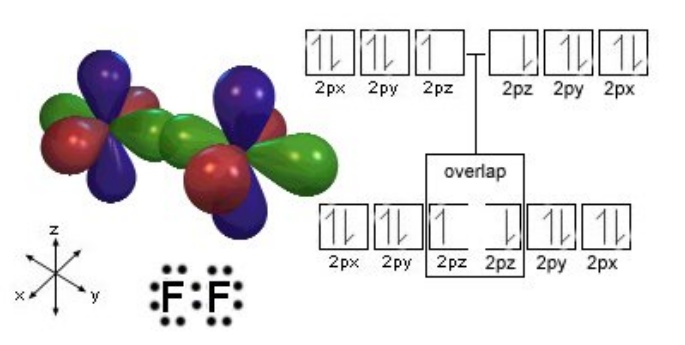
Hybrid Orbitals

➢As the two hydrogen atoms move closer, the potential energy decreases. The bond distance is the distance of lowest energy.



Hybrid Orbitals

➢We already have discussed how atoms share electrons so they can fill their outermost S & P orbitals. Orbitals overlap to form a bond.



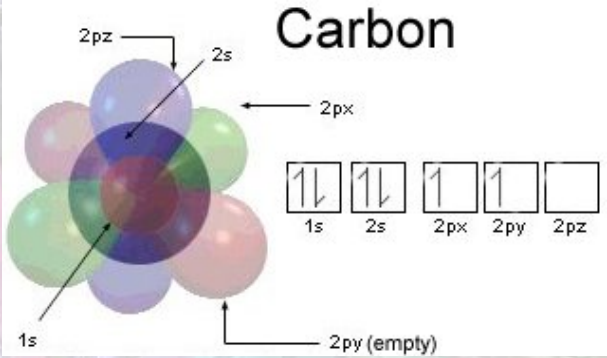
Hybrid Orbitals

➢**Hybridization** is a theory that helps explain the shapes of some molecules. We'll look at the hybridization of the carbon atom.

- ➢Write carbon's electron config: _____
- ➢Carbon has 2 half-filled 2p orbitals – this would make you think that carbon could form 2 bonds, but experiments prove otherwise. Carbon can make 4 bonds – it acts like it has 4 unpaired electrons.
- ➢The explanation is hybrid orbitals – a theory proposed by Linus Pauling.
- ➢Carbon's 2s and 2p orbitals hybridize – we call these "sp^3" orbitals. The s has a superscript of 1(implied) and p a superscript of 3 ➔ 4 electrons

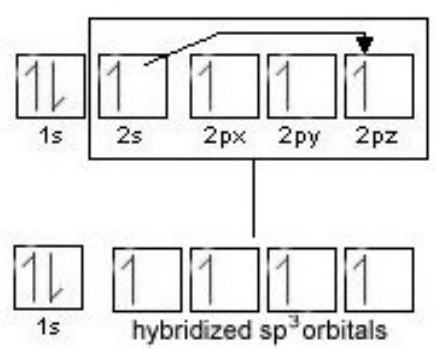
Hybrid Orbitals

Carbon's "standard" electron configuration:



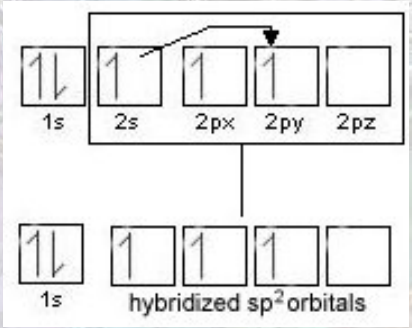
Hybrid Orbitals

How carbon hybridizes its electrons:



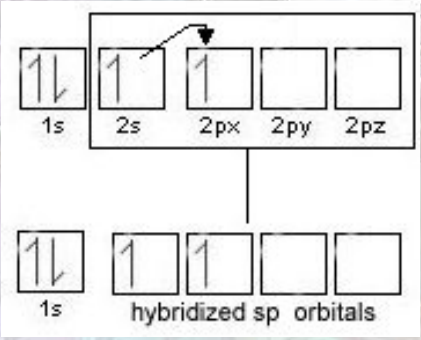
Hybrid Orbitals

Other atoms hybridize also → Boron will form sp^2 orbitals – 3 unpaired e^- ➔ it can form 3 bonds



Hybrid Orbitals

Beryllium will form sp orbitals – 2 unpaired e^- ➔ it can form 2 bonds

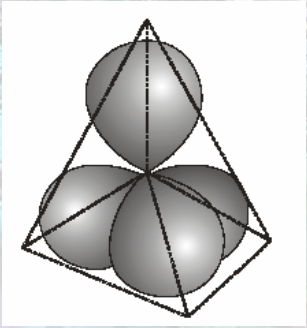


Hybrid Orbitals

Molecular shapes are also influenced greatly by the Valence-Shell Electron-Pair Repulsion Theory (VSEPR), pronounced "vesper". The atoms align themselves so as to maximize the distance between the valence electron pairs, including lone pairs.

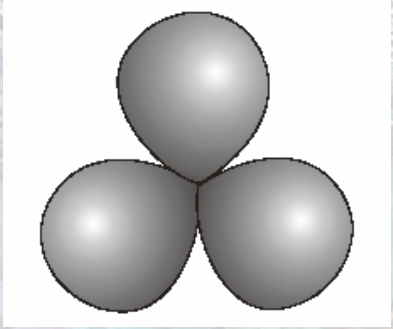
Hybrid Orbitals

The sp^3 hybridization leads to a tetrahedral shape (all angles 109.5°)



Hybrid Orbitals

The sp^2 hybridization leads to a trigonal planar shape (all angles 120°)



Hybrid Orbitals

The sp hybridization leads to a linear shape (180° angle)