Sigma (σ) and Pi (π) Bonding

<u>Sigma bond</u>: covalent bond formed by orbitals overlapping end to end. The electron density is concentrated between the nuclei of the two atoms involved in a bond.

s-orbital   s-orbital   constructive interference (in phase)   electron probability density increases   σ bonding orbital

Half-filled p_x orbital   +   Half-filled p_x orbital   →   σ bond

<u>Pi bond</u>: covalent bond formed by orbitals overlapping side by side. The electron density is concentrated above and below the nuclei of the two atoms involved in a bond.

Half-filled p_y or p_z orbital   +   Half-filled p_y or p_z orbital   →   π bond

Bond Type	Made of	Length / Strength
single bond	_1_ sigma bond	longest/ weakest
double bond	_1_ sigma bond + _1_ pi bond	medium length/ strength
triple bond	_1_ sigma bond + _2_ pi bonds	shortest/ strongest

Let's Practice! Identify the number of sigma and pi bonds in each structure shown below:

sigma bonds _3_
pi bonds _1_

# sigma bonds _8_
pi bonds _3_

Hybridization

Hybrid Orbitals: orbitals of equal energy created by ___blending___ two or more valence orbitals on the same atom

- The same type of atom can have ___different___ types of hybridization depending on the atoms it is bonded with.
- Hybridization can be determined by counting regions of ___electron___ density: electron domains!

# of Electron Domains	# of Hybrid Orbitals	Electron Geometry	Hybridization
2	2	Linear	sp
3	3	Trigonal planar	sp^2
4	4	Tetrahedral	sp^3
5	5	Trigonal bipyramidal	sp^3d
6	6	Octahedral	sp^3d^2

] Not
AP tested!

Example: Carbon in CH₄

Atomic Orbitals   Hybrid Orbitals
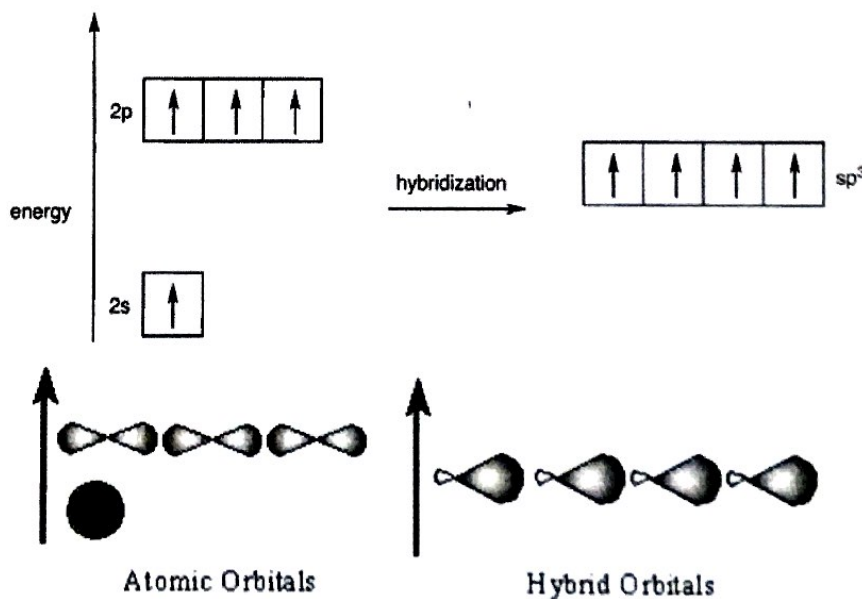
Let's Practice! Identify the hybridization of the valence orbitals around the central atom in each molecule below.

1)	2)	3)

1)

H
|
:N—H
|
H

electron domains? __4__

hybridization? __Sp^3__

2)

H—C≡N:

electron domains? __2__

hybridization? __Sp__

3)

(structure of H₂CO with C=O)

electron domains? __3__

hybridization? __Sp^2__