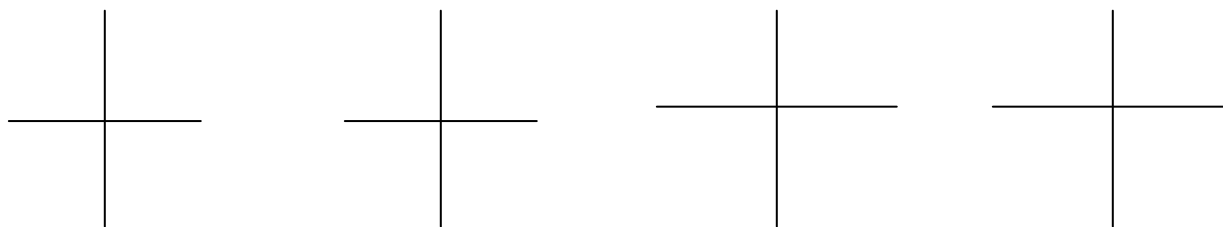


Chapter 1. Structure and Bonding

Atomic Structure

Quantum Mechanics tells us that electrons in atoms exist in allowed energy states called _____.



Notice the _____ in the 2p orbitals:

Three rules for determining the _____ electron configuration:

- 1.
- 2.
- 3.

Give the ground state electron configurations of:

H

C

Br



Three different models are used to explain why atoms form bonds.

Bonding Model Number 1:

The octet rule:

Three examples:

H₂

NaCl

CH₄

Important Learning Objective: Be able to draw the complete Lewis Structure of any compound.

Shortcut: It is easy to predict the number of bonds that an atom of a particular element can form:

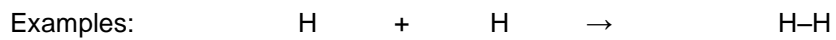
Examples: Draw the Lewis Structure (also called “Kekulé Structure” or “Line-Bond Structure”) of these compounds:

compound	Lewis Structure	Condensed Structural Formula
C ₂ H ₆		
CH ₅ N		
CH ₄ O		
C ₂ H ₄		
C ₂ H ₂		
CH ₂ O		
C ₂ H ₆ O		

Bonding Model Number 2:

Terms associated with VBT:

The main idea behind _____:



sigma bond (σ bond)

pi bond (π bond)

1 single bond =

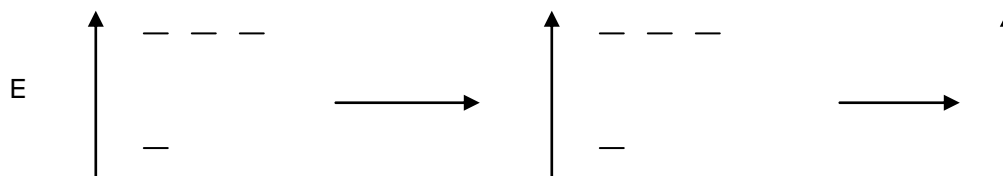
1 double bond =

1 triple bond =

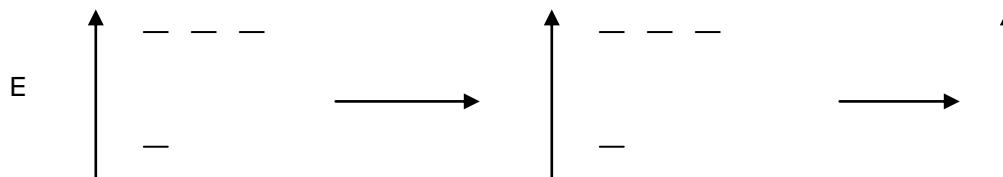
- Whenever simple atomic orbital overlap is inadequate to explain certain bond properties (such as equivalency of bonds, bond angles, etc.) the concept of _____ is invoked.
- The process of _____ corresponds to a mixing of orbitals (an imaginary process accomplished mathematically) resulting in new orbitals called _____.

Thought experiment. Give electron configuration of a ground state C atom.

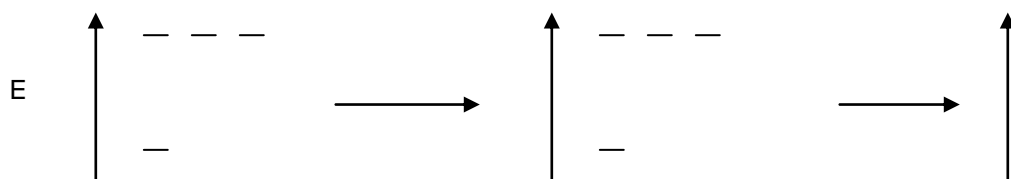
sp^3 hybridization:



sp^2 hybridization:



sp hybridization:



Be able to determine the hybridization of any atom in a molecule.

Count the number of

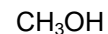
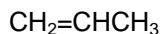
plus the number of

If # σ bonds + # lone pairs = 2, then

If # σ bonds + # lone pairs = 3, then

If # σ bonds + # lone pairs = 4, then

Example: Determine the hybridization of every non-hydrogen atom in each molecule below:



Key point in Valence Bond Theory: The better the _____, the _____ the bond.

There are two ways to quantitatively describe the strength of a covalent bond:

1.

2.

Bond Dissociation Energy (D):

example: H₂

Important: Bond Breaking is always _____ (or _____)

Bond Formation is always _____ (or _____)

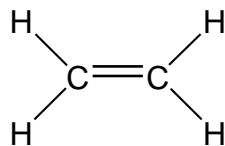
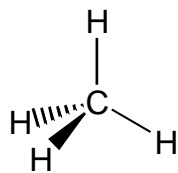
Bond Length:



Question: Why isn't a double bond twice as strong as a single bond?

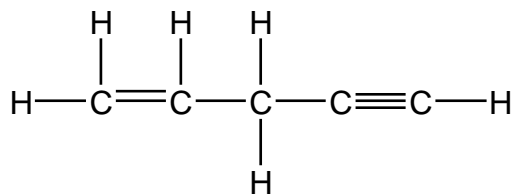
Why isn't a triple bond three times as strong as a single bond?

Compare the C-H bond lengths and bond strengths in these molecules:



Example: In the molecule below, determine:

- the hybridization of each C atom
- the relative strength and bond length of each C-C bond
- the relative strength and length of each C-H bond



Bonding Model Number 3:

1. Summary of Molecular Orbital (MO) Theory:

- Quantum Mechanics says :

Electrons in _____ exist in allowed energy states called _____

Electrons in _____ exist in allowed energy states called _____

- Think of MOs this way: they are formed from a _____
- Two important types of MOs:
- Determining MO electron configuration is analogous to determining AO electron configuration:

2. Atomic Orbitals (AOs) and Molecular Orbitals (MOs):

- Two equivalent AOs will interact to form 2 MOs:
- The Bonding MO is _____ in energy than the AOs.
- The antibonding MO is _____ in energy than the AOs, and it has a _____ between the two atoms.
- One way to understand this: AOs and MOs are wave functions (QM says e^- have wave characteristics).
 - Two AOs can overlap constructively (wave reinforcement) to form a _____ MO.
 - Or they can overlap destructively (wave cancellation) to form an _____ MO.

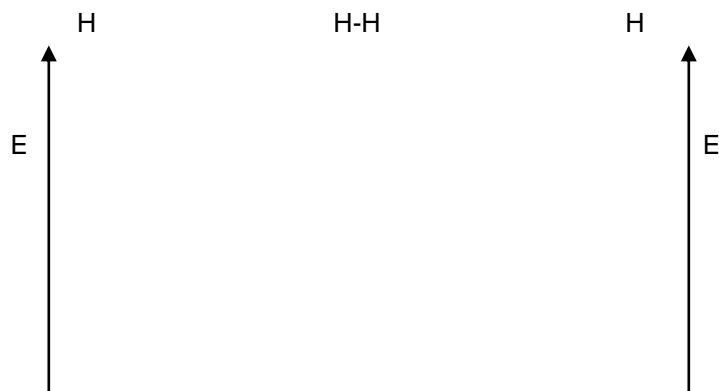
3. Bonding MOs are designated _____ and _____ MOs.

Antibonding MOs are designated _____ and _____ MOs

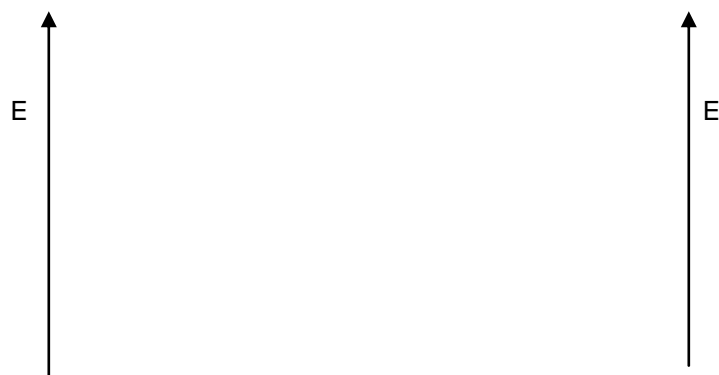
(pronounced "sigma star" and "pi star" molecular orbitals).

4. When two equivalent s orbitals combine, they result in a _____ bonding MO and a _____ antibonding MO

Example: $H + H \rightarrow H-H$



4. When two parallel p orbitals combine, they result in a _____ bonding MO and a _____ antibonding MO.



Drawing Chemical Structures

Be able to draw the condensed structure and skeletal structure of any organic compound.

Skeletal structures: 1) _____ and _____ atoms are usually not shown.

2) You should mentally supply sufficient hydrogen atoms by knowing that:

Examples:

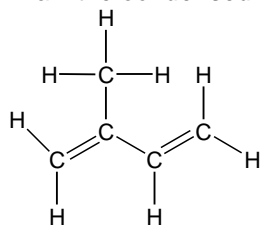
propane

pentane

2,3-dimethylpentane

cyclohexane

Draw the condensed structure and the skeletal structure of isoprene, given the following Lewis structure:



Show the reaction of 1-butene with bromine, using condensed structures and skeletal structures:

Two common mistakes to avoid:

1. Don't give carbon _____

2. Don't imagine carbons _____

Draw the condensed structures and the skeletal structures of:

1-butanol

1-bromopropane

3-chloropropene