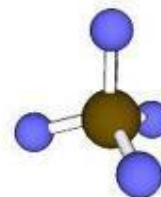


Molecular Structure



I. Periodic Table

II. Ionic vs. Covalent Compound Structure

III. Electron Distribution

A. Lewis Dot diagram

Homework: Worksheet 13.1

IV. Electron Pair Repulsion

A. Shared vs. Unshared Pairs

Homework: Worksheet 13.2

C. Strength of Repulsions

D. Important Examples

V. Multiple Bond Repulsions

Homework: Worksheet 13.3

A. double bonds

B. triple bonds

C. Saturated vs. Unsaturated

Homework: Worksheet 13.4

VI. Hybrids

Homework: Worksheet 13.5A. sp^3 , sp^2 , sp

B. examples

VII. Resonance

Homework: Worksheet 13.6

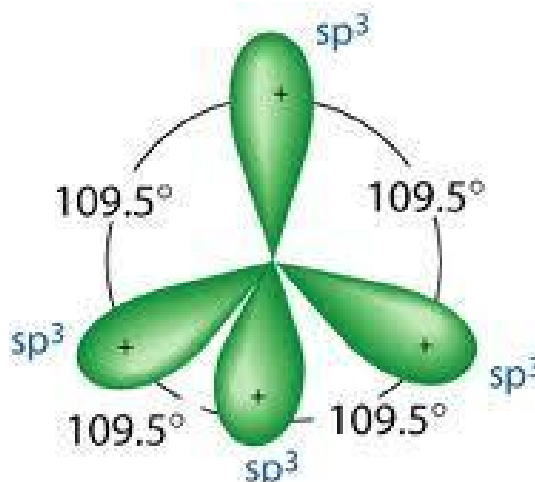
A. Delocalized

B. Conjugated

LAB ACTIVITY 13-1

VIII. Chapter Review Sheets

IX. TEST Chapter 13



Chapter 13: *Molecular Structure*

Objectives:

- a) use models to explain the structure of a given molecule
- b) describe hybrid orbitals and use hybridization theory to explain the bond angles in compounds
- c) differentiate between sigma and pi bonding

I. Electron Distribution

Lewis Electron Dot Diagram

- a) Arrange the outer electrons at dots around the atoms so that each ends up with a _____.
- b) For all atoms that form covalent bonds, except **hydrogen**, _____ represents a full outer level.
- c) Rules for drawing electron dot structures:
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.

Examples:



d) Shared Pairs vs. Unshared Pairs

Shared Pairs →

Unshared Pairs →

How many unshared pairs are **on the central atom** in each of the examples on the previous page?

	H ₂ O	AsI ₃	H ₂ Te	PF ₃	NI ₃	CBr ₄
Unshared Pairs						
Shared Pairs						

II. Valence Shell Electron Pair Repulsion (VSEPR Theory)

- a) Electron pairs spread as far apart as possible to _____.
- b) The numbers and types of repulsions determine the _____.

example: BeF₂

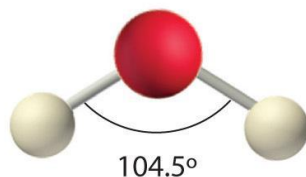
example: BF₃

c) Tetrahedron: BASE STRUCTURE

example: CH₄

Replace one shared pair with an unshared pair:

Replace another shared pair with an unshared pair:



d) Bonds and unshared pairs affect the _____.

e) Unshared pairs have a _____ than a shared pair.

Unshared pair is acted upon by only _____.

Shared pair is acted upon by _____.

f) Repulsions vary:

unshared-unshared

unshared-shared

shared-shared

g) Three **VERY** Important Examples:

1) **methane = CH₄**

→ all pairs of electrons around the central atom are shared therefore

_____.

→ _____ (bond angles all _____)

2) ammonia = NH_3

→ unshared-shared repulsions _____ shared-shared repulsions

→ unshared pair _____ (____°)

→ _____.

3) water = H_2O

→ _____ pairs and _____ pairs

→ Interactions: _____; _____; _____

→ 2 unshared pairs repel each other the most making the bond angle

_____ (____°)

→ _____

III. MULTIPLE BONDS:

a) Two atoms can form covalent bonds by sharing _____.

For example:



b) A **DOUBLE** Covalent Bond

- 1) Shares _____ pairs of electrons between 2 atoms
- 2) _____;
- 3) May give _____ or _____ shapes.

For Example: CH_2O

CO_2

c) A **TRIPLE** Bond

- 1) Share _____ of electrons between two atoms.
- 2) _____
- 3) Have an even _____
- 4) **Always** give a _____ shape.

For Example: C_2H_2

N_2

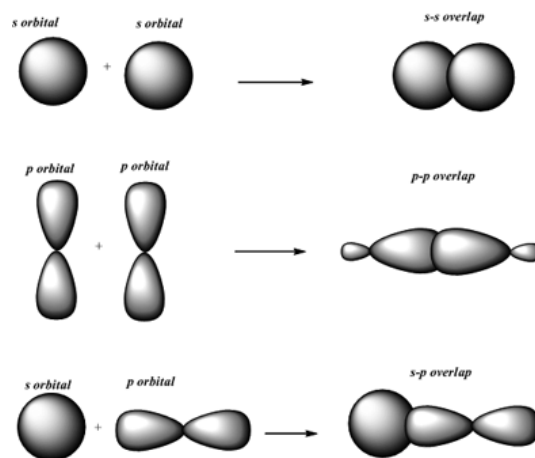
d) **Saturated**- When a molecule contains **all** _____ bonds.

e) **Unsaturated**- when a molecule has at least _____ bond.

For Example:

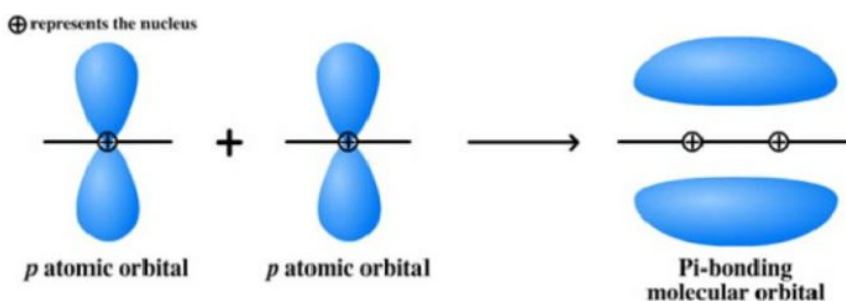
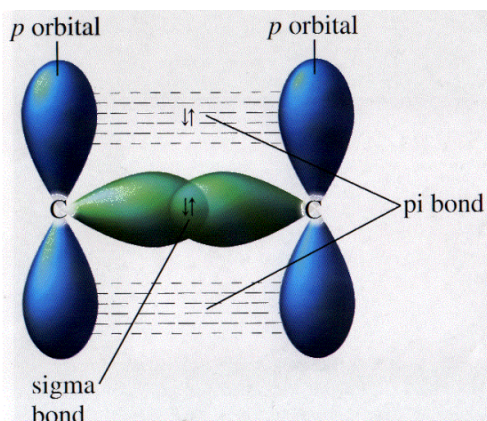
f) Sigma and Pi Bonds

- 1) Sigma Bonds (σ) - formed when two orbitals overlap _____ to form a covalent bond. Single bonds are _____ bonds.



2) Pi Bonds (π) - when two p orbitals bend _____ (_____)

- the _____ in a double bond is a π bond.
- the _____ in a triple bond are π bonds.
- they are _____ and can be _____ than sigma bonds.



- A double bond is composed of one _____ bond and one _____ bond.
- A triple bond is composed of one _____ bond and two _____ bonds.

—

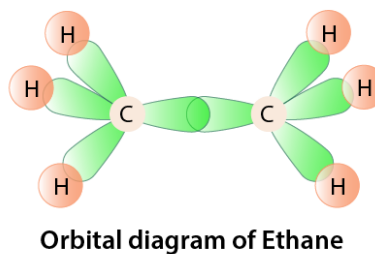
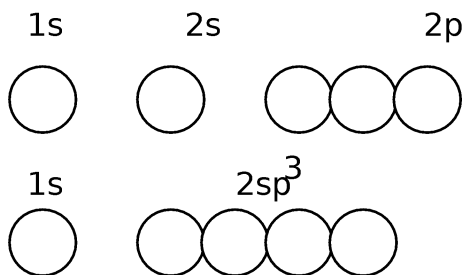
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≡

IV. Hybrid Orbital Theory: Another way of determining molecular geometry.

- This model considers the different ways which _____ when sharing electrons.
- This model is best illustrated by looking at _____.

a) sp^3 Hybrid:



sp^3 is called a HYBRID Orbital : it is a hybrid of _____

one s + three p $\square$ _____ hybrid orbitals $s+p+p+p$ $\square$

These four equivalent orbitals are helpful in understanding the tetrahedral arrangement for four bonds on a central atom. Ex. CH_4

Example: Ethane C_2H_6

A carbon atom can form _____ equivalent bonds by covalent linkage $\rightarrow$ many, many possibilities for compounds.

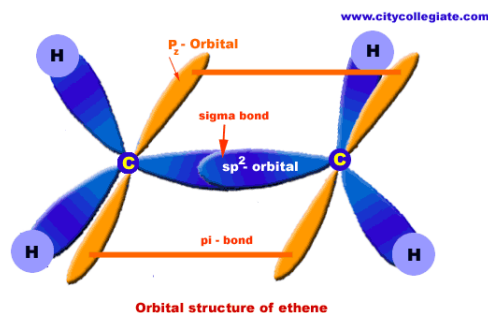
b) **sp^2 Hybrid** $\rightarrow$ a combination of one s and two p orbitals, one p orbital is left unhybridized



sp^2



unhybridized p



sp^2 is also a hybrid orbital. It is a hybrid of one s + two p $\square$ _____ hybrid orbitals $s + p + p$ $\square$

Ex. C_2H_4

c) **sp Hybrid** → combination of _____ orbitals; two p orbitals are left unhybridized.

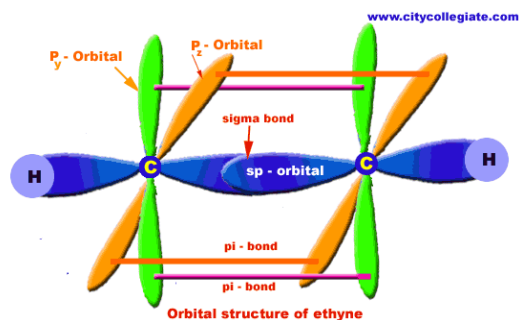
one s + one p = _____ hybrid orbitals



sp hybrid



unhybridized p



Example: C_2H_2

d) How to determine what type of hybridization a molecule has:

$$\# \text{ bonds} + \# \text{ Unshared pairs} = \# \text{ electron clouds}$$

electron clouds on central atom hybridization type

2

sp

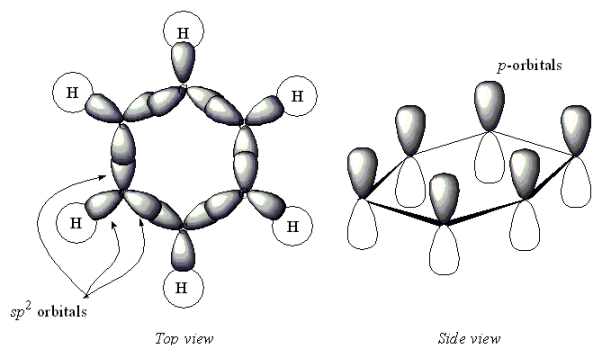
3

sp^2

4

sp^3

V. **BENZENE:** $C_6H_6 \rightarrow$ _____ ring C



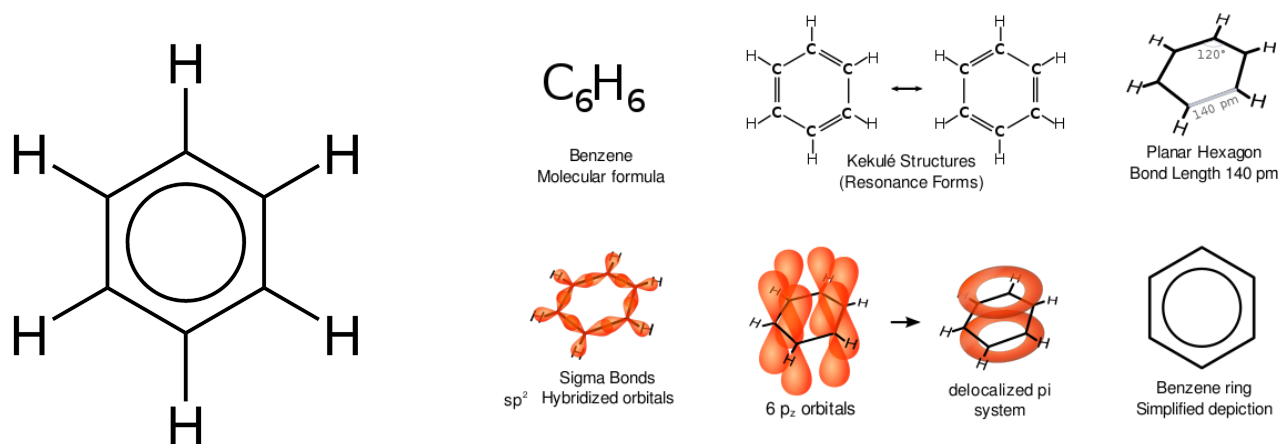
C hybridizes to sp^2

6 σ bonds between _____

6 σ bonds between _____

3 π bonds between _____

- a) **Delocalized π electrons** $\rightarrow$ the 6 electrons in the p orbitals of benzene are _____, above and below the plane of the molecule.

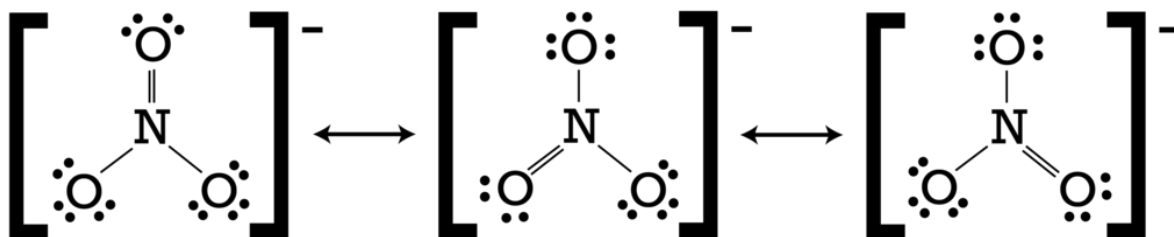


- b) **Conjugated System:** whenever _____, a special stability is gained.

VI. **RESONANCE:** _____ for a molecule or polyatomic ion which predicts _____.

Example: Benzene

Example: Nitrate Ion NO_3^{-1}



- Experimental evidence suggests that all bond lengths are _____.
- Need _____ to describe this.
- Be sure to include _____, _____, and _____ in your resonance structures.

Try This one: Carbonate Ion