

## Announcements – 11/17/00

### ■ Exam #3

- Grading will be done Monday, 11/20
- Solution Key will be online by Monday, 11/20

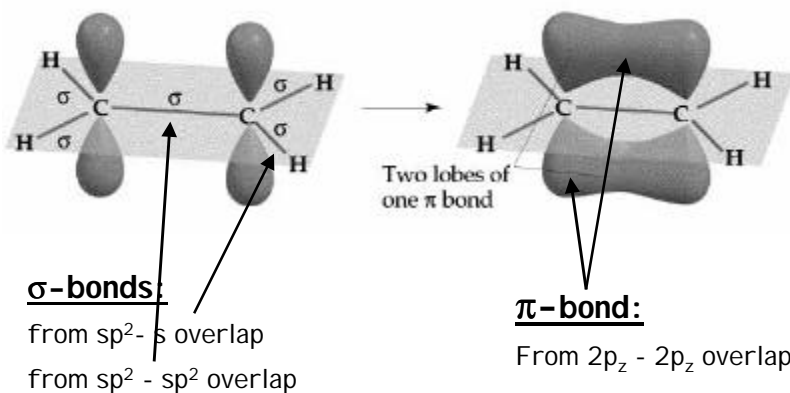
### ■ Tuesday review/problem session?

- If interested, let me know before Monday

### ■ No office hour today

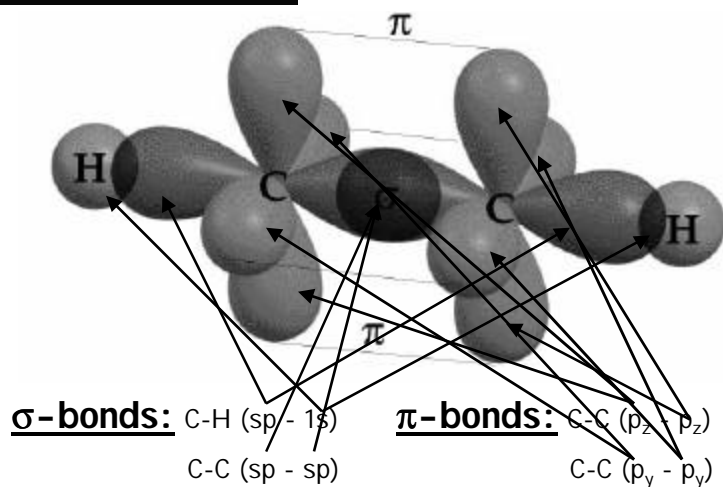
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## Ethylene ( $C_2H_4$ ) Bonding



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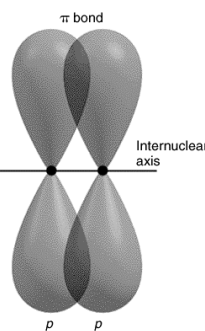
## C<sub>2</sub>H<sub>2</sub> (Acetylene) Bonding



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## Multiple Bonds

- **Single Bonds**
  - End-on orbital overlap: **σ-bond**
- **Double Bonds**
  - **σ-bond** plus a **π-bond**
- **Triple Bonds**
  - **σ-bond** plus **TWO π-bonds**



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## Delocalized Bonding

- How can we better understand the bonding represented by Lewis *resonance structures*?

Example:  $\text{NO}_3^-$

-three Lewis resonance structures

-1 N=O bond and 2 N-O bonds: 3 possible combinations

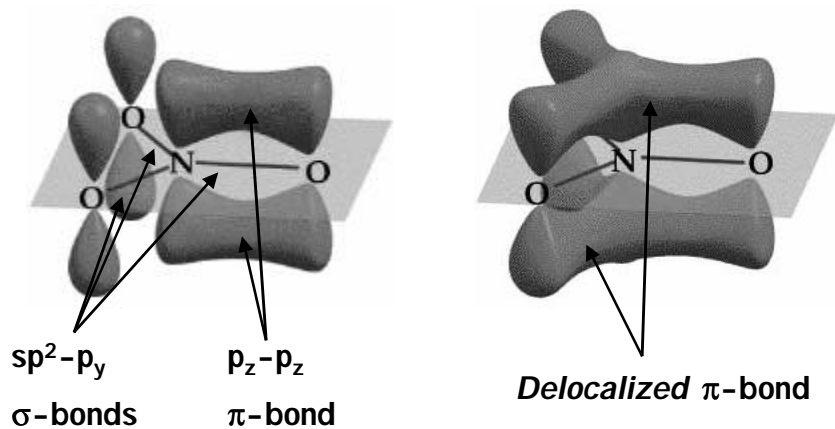
-trigonal planar geometry:

-N: 3  $e^-$  in  $sp^2$  hybrid orbitals  
1  $e^-$  in  $p_z$  orbital

-O: 2 unpaired  $e^-$  in  $p_z$  and  $p_y$  orbitals

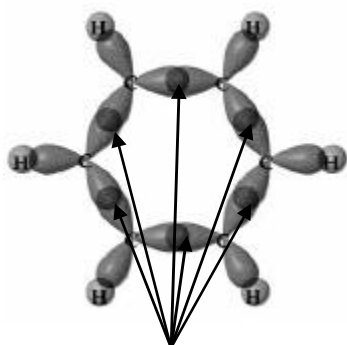
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## Bond Delocalization in $\text{NO}_3^-$

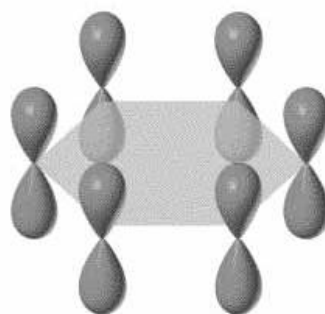


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## Benzene (C<sub>6</sub>H<sub>6</sub>)



$\sigma$ -bonds:  $sp^2 - sp^2$  (C-C)



Carbon  $p_z$ -orbitals

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## Benzene: Delocalized $\pi$ -orbitals



Localized  $\pi$ -bonds

(two structures possible)



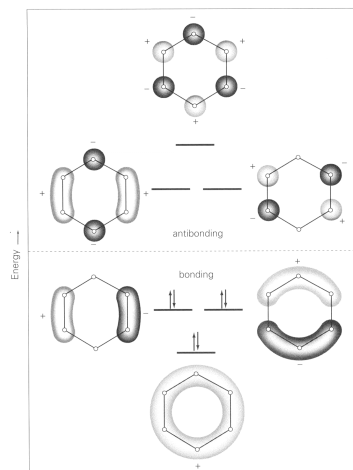
Delocalized  $\pi$ -bonding

(*one* structure only)

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## Delocalized Orbital Energies

- Delocalized e<sup>-</sup> fill a *new* set of **molecular orbitals** formed by linear combinations of the six carbon p<sub>z</sub>-orbitals:



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## *Spectroscopy: Probing Atoms and Molecules*

- Atomic emission spectroscopy was a critical link to the structure of *electrons* inside the atom

***Can we learn more about these systems with spectroscopy?***

**Let's take a look . . .**

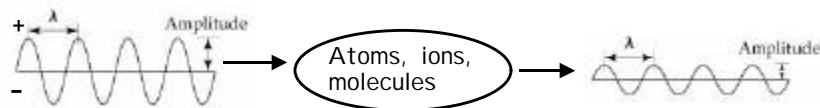
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# One View of EMR/Matter Interactions

## ■ Resonance

-EMR as *oscillating electric field* propagating through space

-if the *frequency* of oscillation matches a *natural* oscillation frequency of the system, the system can **absorb** energy from the EMR, reducing its amplitude:



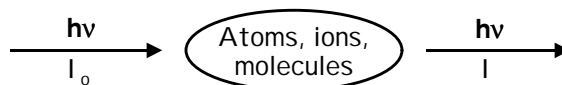
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# Another View

## ■ Quantum

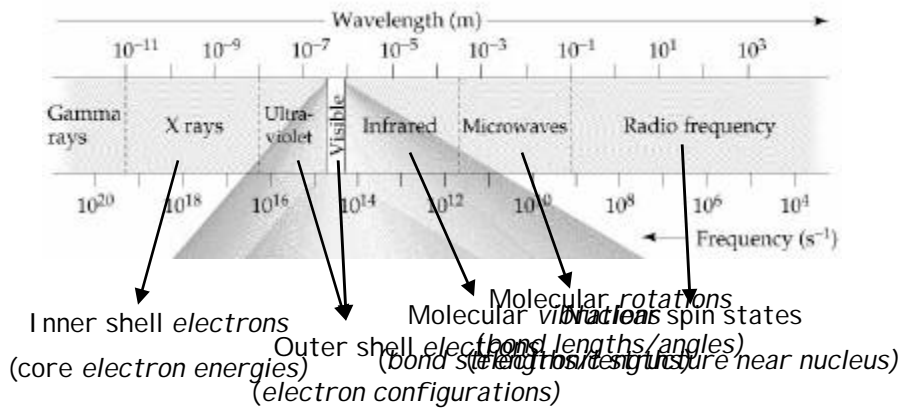
-EMR as a stream of photons propagating through space

-if the *energy* of a photon *matches the energy of a **transition*** between two energy states of the system, the photon can be absorbed by the system, raising it to the excited state:



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# What can we "see" with Spectroscopy?



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