Lecture 27
Chapter 9  Sections 2-3

- Lewis Structures
- Resonance
- VSEPR
Announcements

- CAPA #15 due tomorrow
- Seminar tomorrow 11:00
- Seminars Friday 3:00 and 4:00
- Seminar next Tuesday at 11:00
Building the Lewis Structure

An outer atom other than hydrogen is most stable when it is associated with an octet of electrons.
Example: $\text{CH}_3\text{NH}_2$

**BUILDING LEWIS STRUCTURES**

Step 1 Count the valence electrons.
Step 2 Assemble the bonding framework, placing two electrons per bond.
Step 3 Place three nonbonding pairs of on electrons each outer atom, except H.
Step 4 Assign the remaining valence electrons to inner atoms.
Step 5 Optimize electron configurations of the inner atoms.
Step 6 Identify equivalent or near-equivalent Lewis structures.
Example:  Acrylonitrile  \( \text{H}_2\text{CCHCN} \)

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Example for group work: ethylene $\text{H}_2\text{CCH}_2$
Beyond the Octet

• The most common elements: C, N, O always have filled octets
• Elements in the 3\textsuperscript{rd} row or higher can have more than an octet if needed
• Valence d orbitals provide root to accommodate more than eight valence electrons.
Example: $\text{SF}_4$

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Formal Charge

- Formal charge = 
  \((\text{Normal valence electrons}) - (\text{Assigned valence electrons})\)

\[ FC = \text{Normal valence} - (\frac{1}{2}\text{bonding e}^- + \text{lone pair e}^-) \]

\textit{e.g.} formaldehyde \( \text{H}_2\text{CO} \)

\[
\begin{array}{c}
\text{H} \quad \text{H} \\
\text{C} \quad \text{H} \\
\end{array}
\quad \leftrightarrow 
\begin{array}{c}
\text{H} \quad \text{H} \\
\text{C} \\
\end{array}
\]
Example for you: phosphoric acid $\text{H}_3\text{PO}_4$

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<thead>
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Resonance

- When multiple, equivalent Lewis structures may be drawn
- Resonance indicates stability
Example for you: $\text{CO}_3^{2-}$

**BUILDING LEWIS STRUCTURES**

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Molecular Shapes
Electron Pair Repulsion

• Molecules have three dimensional shape.
  – The 3-D shape defines the properties of the molecules.
• How do we predict the shape?
• **VSEPR Theory** – valence shell electron-pair repulsion theory
  – Electron pairs in the outer shell of an atom try to get as far away from each other as possible
  – Why? Because like charges repel…they want to be far away from each other.
• The result? 2 electron pairs ➔ line
  3 electron pairs ➔ trigonal planar (triangle)
  4 electron pairs ➔ tetrahedron (pyramid)
Electron pairs get away from each other

2 electron ‘groups’

Two C–H bonds optimally separated in space.

3 electron groups

Three C–H bonds optimally separated in space.

4 electron groups

Four C–H bonds optimally separated in space.
• In the plane of the paper, it looks like the bond angles are 90°.
• But, we know that the molecule exists in three dimensions.
• The bonds are really optimized around the central carbon.
• The shape is called tetrahedral and has bond angles of 109.5°.
Today

- CAPA #15 due tomorrow
- Seminar tomorrow

Friday

- Finish Chapt 9
- Two seminars 3:00 SC1019 4:00 SC1000

Remember: You are done with the homework when you understand it!