A Brief Review

Organic Chemistry – study of
  • Bonds with
  • > million compounds

Bonding -- 2 ways to achieve

1. Ionic bond
   Ex:  \( \text{Na} + \text{Cl} \rightarrow \)

2. Covalent bond
   Ex:  \( \text{H} + \text{H} \rightarrow \)

Lewis Structures (molecules/ions): dots = lines =

Common Bonding Patterns

<table>
<thead>
<tr>
<th></th>
<th>Carbon</th>
<th>Nitrogen</th>
<th>Oxygen</th>
<th>Hydrogen</th>
<th>Halogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonds</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lone prs.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Ex:  Draw the Lewis structure for CH$_3$CN

Formal charge: to determine charge on atom or polyatomic ion

\[ \text{F.C.} = \# \text{valence e- in neutral atom} - (\text{all unshared e-} + \frac{1}{2} \text{shared e-}) \]

Ex:  Determine which atom bears the charge on H$_3$O$^+$
Electronegativity -- Measure of  
See Figure 1-6

$\Delta EN = 0.5 - 1.9 \rightarrow$

Dipole moment - ( ) defined as

Ex:  $\text{C} - \text{H}$  $\text{O} - \text{H}$  $\text{C} - \text{Cl}$

Note: Polarity of Molecule depends on

Resonance -- when single
  • Valence e⁻

Ex: Acetate ion (CH$_3$CO$_2^-$) $\rightarrow$ 2 possible Lewis Structures
## Writing Organic Compounds

<table>
<thead>
<tr>
<th>Compound</th>
<th>Lewis</th>
<th>Condensed</th>
<th>Line-angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pentane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>acetone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cyclohexanol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Acids & Bases

**Bronsted-Lowry:**

- Acids $\rightarrow$
- Bases $\rightarrow$

\[
\text{HCl} + \text{NaOH} \rightarrow
\]

- **Strong**
- **Weak**

**Strength measured by:**

\[
\text{HA} + \text{H}_2\text{O} \leftrightarrow
\]

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\[ K_a = \]
\[ pK_a = \]
\[ pK_a \quad \text{acid strength} \]

**Stronger acid \rightarrow**

**Acid-base reactions \rightarrow**

What about bases?

Acidity of Organic Acids \rightarrow

4 main factors:

1. **Electronegativity** of atom bonded to acidic H
   - More EN \rightarrow

   Ex: \[ \text{H}_3\text{C}—\text{H} \quad \text{HO—H} \]

2. **Size** of atom bonded to acidic H
   - Bigger \rightarrow

   Ex: \[ \text{HI} \quad \text{HF} \]

3. **Resonance**
   - Is conjugate base

   Ex: \[ \text{CH}_2\text{CH}_2\text{OH} \quad \text{(ethanol)} \]
   \[ pK_a = 15.9 \]

   \[ \text{CH}_3\text{COOH} \quad \text{(acetic acid)} \]
   \[ pK_a = 4.76 \]
4. Inductive Effect

- Positive charge withdraws e- from H—A bond →

\[
\text{H}_3\text{C} - \text{C} - \text{O} - \text{H}
\]

Acids & Bases Take 2

Lewis:

- Acid →
- Base →

\[
\overset{\text{A}}{\text{H}} + \overset{\text{B}}{\text{H}}^+ \rightarrow \text{A} - \text{B}
\]

\[
\overset{\text{H}}{\text{H}} + \overset{\text{N}}{\text{N}}^+ \rightarrow \overset{\text{H}}{\text{H}}\overset{\text{N}}{\text{N}}\overset{\text{H}}{\text{H}}
\]

Curved arrows →

End of Chpt. 1

Shapes of Molecules →

Valence Shell Electron Pair Repulsion Theory (VSEPR)

- Valence e- repel .:
- Unshared e- repel

Ex: CH₄ (methane)

\[
\overset{\text{H}}{\text{H}}\overset{\text{C}}{\text{C}}\overset{\text{H}}{\text{H}}
\]

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Lewis Structures only predict shape →

Bonding: Sharing e- by

**Sigma (σ) bond** – overlap along bonding axis

\[
\begin{array}{c}
\text{H} \\
\text{1s}
\end{array} + \begin{array}{c}
\text{H} \\
\text{1s}
\end{array} \rightarrow \begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

\( \text{sigma bond} \)

C, N, O → also use p

**Hybridization:** \( sp^3, sp^2, sp \)

<table>
<thead>
<tr>
<th>Hybridization</th>
<th>Hybridized orbital</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>s + p + p + p ( \rightarrow )</td>
<td></td>
<td>CH(_4)</td>
</tr>
<tr>
<td>s + p + p ( \rightarrow )</td>
<td></td>
<td>CH(_2)CH(_2)</td>
</tr>
<tr>
<td>s + p ( \rightarrow )</td>
<td></td>
<td>C(_2)H(_2)</td>
</tr>
</tbody>
</table>

**Pi (π) bond** → sharing of e- by → double bond →

*Bond length: triple*<
**Summary Hybridization**

<table>
<thead>
<tr>
<th># bonding “areas”</th>
<th>Hybridization</th>
<th>Bond Types</th>
<th>Angles*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td>4 – sigma</td>
<td>109.5°</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>3 – sigma</td>
<td>120°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 – pi</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>2 – sigma</td>
<td>180°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 – pi</td>
<td></td>
</tr>
</tbody>
</table>

*Ex: Determine the hybridization and bond angles and label the bond types for hydrogen cyanide (HCN).

**Single bonds** – allow
→ lots of

**Double bonds** –
→ results in

**Def:**

- **Isomer**
- **Constitutional Isomer**
- **Stereoisomer**
- **Others**
- **Geometric**
Molecular dipole moment \( \rightarrow \) is the molecule

Must consider &

Ex: \( \text{C}_4\text{H}_{10} \)

2-butene

Ex: \( \text{CCl}_4 \)

\( \text{CHCl}_3 \)

Why important?

Types of Intermolecular Interations:

1. dipole-dipole

Ex: \( \text{CH}_4 \)

\( \text{CH}_3\text{OH} \)

b. pt. =

b. pt. =

2. London dispersion ( )

Ex: \( \text{CHCl}_3 \)

\( \text{CCl}_4 \)

b. pt. =

b. pt. =
3. Hydrogen bonding

Ex: \( \text{CH}_3\text{OCH}_3 \)  
  b. pt. =  

CH\(_3\)CH\(_2\)OH  
  b. pt. =

Solubility → “

Ex: Salt + water  
    Salt + gasoline  
    Wax + gasoline  
    Wax + water

Functional Groups
→ Have specific  
→ Gives compound

\[
\text{H}_3\text{C}-\text{C}-\text{H}_3
\]
  Alkane (not true F.G.)

\[
\text{C}==\text{C}
\]
  Alkene

\[
\text{C}==\text{C}
\]
  Alkyne

\[
\begin{array}{c}
\text{C} - \text{O} - \text{H} \\
\end{array}
\]
  Alcohol

\[
\begin{array}{c}
\text{C} == \text{C} \\
\end{array}
\]
  Arene

\[
\begin{array}{c}
\text{C} == \text{C} \\
\end{array}
\]
  Phenol

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These groups contain a **Carbonyl Group** (not a functional group):

- **Thiol**
- **Ether**
- **Amine**

**Examples:**

- Aldehyde
- Ketone
- Carboxylic Acid
- Ester
- Amide
- Acetic Anhydride

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