Welcome to day 4!

- Announcements
- Molecular Representations
- Naming & Nomenclature
What kind of ion does Sr like to form?

<table>
<thead>
<tr>
<th>25%</th>
<th>1.  +1</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>2.  +2</td>
</tr>
<tr>
<td>25%</td>
<td>3.  -1</td>
</tr>
<tr>
<td>25%</td>
<td>4.  -2</td>
</tr>
</tbody>
</table>
Announcements

• Seminar Friday – 4:00 this room
  – Extra credit is available (see chemboard)
Molecular Representations & Naming

• Communication of ideas is critical to science
• Must have standard notation for identifying molecules
• We’ll see several standards today
  – Chemical formula
  – Structural formula
  – Line structures
  – Names

• We’ll go through rules quickly – get to example
Chemical Formula

- The chemical formula of a substance gives the relative numbers of atoms of each element. For example,
  - Water \( \text{H}_2\text{O} \)
  - Glucose \( \text{C}_6\text{H}_{12}\text{O}_6 \)
  - Caffeine \( \text{C}_8\text{H}_{10}\text{N}_2\text{O}_4 \)

- But how do we know how to write the formulas? RULES!

Caffeine
\( \text{C}_8\text{H}_{10}\text{N}_2\text{O}_4 \)
MM = 194.2 g/mol
Chemical Formula Rules #1

For binary compounds – containing only two elements:

1. Except for hydrogen, the element farther to left in the periodic table appears first.
   - Examples: KCl, PCl₃, Al₂S₃ and Fe₃O₄

2. If hydrogen is present, it appears last except when the other element is from Group 16 or 17 of the periodic table.
   - Examples: LiH, NH₃, B₂H₆, and CH₄ but H₂O₂, H₂S, HCl and HI

3. If both elements are from the same group of the periodic table, the lower one appears first.
   - Examples: SiC and BrF₃
And if there are more than two elements:

• When three or more different elements occur in a compound, the order depends on whether or not the compound contains ions. (Section 3.3)

• The formulas of carbon-containing compounds start with carbon, followed by hydrogen and the remaining elements appear in alphabetical order
  – $\text{C}_2\text{H}_6\text{O}$, $\text{C}_4\text{H}_9\text{BrO}$, $\text{CH}_3\text{Cl}$ and $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$
Structural Formulas

- Chemical formula conveys ingredients, but not how to put them together.
- Structural formula shows how molecule is connected.
  - Structure and chemical properties closely linked.
• The atoms in a molecule are held together by attractive forces called bonds.

• In the structural formula, the line connecting two atoms represents a bond.

• So, the structural formula allows us to see how the molecules are held together.

• Notice, that two entirely different molecules can have the same chemical formula, but different structural formulas.

• These are called isomers.

• Both (b) and (c) have the chemical formula $C_2H_6O$. 
Molecules are 3-D

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Water</th>
<th>Ammonia</th>
<th>Methane</th>
<th>Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical formula</td>
<td>$\text{H}_2\text{O}$</td>
<td>$\text{NH}_3$</td>
<td>$\text{CH}_4$</td>
<td>$\text{C}_2\text{H}_5\text{OH}$</td>
</tr>
<tr>
<td>Structural formula</td>
<td>$\text{H}―\text{O}―\text{H}$</td>
<td>$\text{H}―\text{N}―\text{H}$</td>
<td>$\text{H}―\text{C}―\text{H}$</td>
<td>$\text{H}―\text{C}―\text{C}―\text{O}―\text{H}$</td>
</tr>
<tr>
<td>Ball-and-stick model</td>
<td><img src="image1" alt="Ball-and-stick model of Water" /></td>
<td><img src="image2" alt="Ball-and-stick model of Ammonia" /></td>
<td><img src="image3" alt="Ball-and-stick model of Methane" /></td>
<td><img src="image4" alt="Ball-and-stick model of Ethanol" /></td>
</tr>
<tr>
<td>Space-filling model</td>
<td><img src="image1" alt="Space-filling model of Water" /></td>
<td><img src="image2" alt="Space-filling model of Ammonia" /></td>
<td><img src="image3" alt="Space-filling model of Methane" /></td>
<td><img src="image4" alt="Space-filling model of Ethanol" /></td>
</tr>
</tbody>
</table>
Line Structures

- Used by advanced chemists
  - You’ll see these at seminars
- Just a shorthand form of structural formula

Allow us to draw molecules in a compact form.

1. All bonds except C – H are shown as lines.
2. C – H bonds are not shown in the line structure.
3. Single bonds are shown as single lines, double bonds as two lines and triple bonds as three lines.
4. Carbon atoms are not labeled
5. All atoms except carbon and hydrogen are labeled with their elemental symbols
6. Hydrogen atoms are labeled when they are attached to any atom other than carbon.
## Line Structure Examples

<table>
<thead>
<tr>
<th>Molecular formula</th>
<th>Structural formula</th>
<th>Line structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_3H_7Cl$</td>
<td><img src="image1" alt="Structural formula" /></td>
<td><img src="image2" alt="Line structure" /></td>
</tr>
<tr>
<td>$C_7H_9N$</td>
<td><img src="image3" alt="Structural formula" /></td>
<td><img src="image4" alt="Line structure" /></td>
</tr>
<tr>
<td>$C_2H_4O_2$</td>
<td><img src="image5" alt="Structural formula" /></td>
<td><img src="image6" alt="Line structure" /></td>
</tr>
</tbody>
</table>
Naming Compounds

• Nonmetallic Binary Compounds – compounds of nonmetals (Also called Covalent Compounds)
  – The element that appears first retains its elemental name.
  – The second element begins with a root derived from its element name and ends with the suffix –ide.
  – When there is more than one atom of a given element in the formula, the name of the element usually contains a prefix to specify the number of atoms present.
Binary Names

• Name the following compounds:
  – $\text{SO}_2$
  – $\text{CS}_2$
  – $\text{BCl}_3$
  – $\text{BrF}_5$
Binary Compounds of Hydrogen

- With Groups 1 and 17 – hydrogen forms diatomic molecules (LiH is lithium hydride and HF is hydrogen fluoride)
- With Groups 2 and 16 – hydrogen forms compounds containing two atoms of hydrogen and the prefix *di*- is omitted (H$_2$S is hydrogen sulfide, CaH$_2$ is calcium hydride)
- Hydrogen with Groups 13 – 15 have unsystematic names

<table>
<thead>
<tr>
<th>Group 13</th>
<th>Group 14</th>
<th>Group 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>B$_2$H$_6$</td>
<td>CH$_4$</td>
<td>NH$_3$</td>
</tr>
<tr>
<td>Diborane</td>
<td>Methane</td>
<td>Ammonia</td>
</tr>
<tr>
<td></td>
<td>SiH$_4$</td>
<td>PH$_3$</td>
</tr>
<tr>
<td></td>
<td>Silane</td>
<td>Phosphine</td>
</tr>
</tbody>
</table>
Compounds That Contain Carbon

- **Organic chemistry** – chemistry of carbon
- **Alkane** – single bonds between carbon atoms
- **Alkene** – double bonds between carbon atoms
- **Alkyne** – triple bonds between carbon atoms
- **Functional groups** – convey particular chemical properties
- **Alcohol** – contains the –OH group, adds the suffix –ol to the name of the alkane with the same carbon framework
Guidelines for Ionic Formulas

1. The cation – anion ratio must give a net charge of zero.
2. The cation is always listed before the anion.
3. The formula of any polyatomic ion is written as a unit.
4. Polyatomic ions are placed in parentheses with a following subscript to indicate ratios different from 1:1.
Tonight

• Work through CAPA #2
• Tutors available tonight

By Friday

• Start on CAPA set #3
• Read Sections 3.4 – 3.5

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