## Chem 110 Problem Set
Lewis Structures, VSEPR, Intermolecular Forces, and Concentrations

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Coord #</th>
<th>Overall Shape</th>
<th>Shape - ignoring e’s</th>
<th>AXE Designation</th>
</tr>
</thead>
</table>
| SOCl₂    | S=6  
O = 0  
2Cl = 2  
8/2 = 4 | [Image: SOCl₂.png] | Trigonal Pyramid | AX3E |
| XeF₂Cl₂  | Xe = 8  
2F = 2  
2Cl = 2  
12/2=6 | [Image: XeF₂Cl₂.png] | Square Planar | AX4E2 |
| MgCl₂    | Mg = 2  
2Cl = 2  
4/2 = 2 | Cl—Mg—Cl | Linear | AX2 |
| CO₂      | C = 4  
2O = 0  
4/2 = 2 | O—C—O | Linear | AX2 |
| IF₃      | I = 7  
3F = 3  
10/2 = 5 | [Image: IF₃.png] | T-shape | AX3E2 |
<table>
<thead>
<tr>
<th>Molecular Structure</th>
<th>Electronic Configuration</th>
<th>Geometric Shape</th>
<th>Bonding Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH₃</td>
<td>N = 5 3H = 3 8/2 = 4</td>
<td>Trigonal Pyramid</td>
<td>AX3E</td>
</tr>
<tr>
<td>AlCl₃</td>
<td>Al = 3 3Cl = 3 6/2 = 3</td>
<td>Trigonal Planar</td>
<td>AX3</td>
</tr>
<tr>
<td>H₂S</td>
<td>S = 6 2H = 2 8/2 = 4</td>
<td>Bent</td>
<td>AX2E2</td>
</tr>
<tr>
<td>PCl₃</td>
<td>P = 5 3Cl = 3 8/2 = 4</td>
<td>Trigonal Pyramid</td>
<td>AX3E</td>
</tr>
<tr>
<td>CO₃²⁻</td>
<td>C = 4 3O = 0 6/2 = 3</td>
<td>Trigonal Planar</td>
<td>AX3</td>
</tr>
<tr>
<td>SO₂</td>
<td>S = 6 2O = 0 6/2 = 3</td>
<td>Bent</td>
<td>AX2E</td>
</tr>
<tr>
<td>Compounds</td>
<td>Lewis Structure</td>
<td>Shape</td>
<td>AXn</td>
</tr>
<tr>
<td>-----------</td>
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</tr>
<tr>
<td>CH₂O</td>
<td><img src="image" alt="CH₂O Lewis Structure" /></td>
<td>Trigonal Planar</td>
<td>AX₃</td>
</tr>
<tr>
<td>PO₄³⁻</td>
<td><img src="image" alt="PO₄³⁻ Lewis Structure" /></td>
<td>Tetrahedral</td>
<td>AX₄</td>
</tr>
<tr>
<td>ClF₄⁺</td>
<td><img src="image" alt="ClF₄⁺ Lewis Structure" /></td>
<td>See-Saw</td>
<td>AX₄E</td>
</tr>
</tbody>
</table>

Please draw the Lewis structure of the following compounds.

- C₂H₆O
- C₃H₅O
- C₂H₂Cl₂
- C₄H₁₀
- C₃H₄
- CH₂O
- N₂O₄
- SO₃
- SO₂
What is the primary intermolecular bonding force in each of the following compounds?

- H-Bond
- Dipole-Dipole
- Dispersion

3) How you would make 500 mL of 0.80 M NaOH from solid NaOH?

\[ \text{MV} = \text{moles} \quad (0.80 \text{ M})(0.500\text{L}) = 0.400 \text{ mole NaOH} \]

\[ 0.400 \text{ mole} \times 40\text{g/mol} \text{ NaOH} = 16 \text{ grams of NaOH} \]

So, add 16 grams of NaOH to a 500 mL container and add enough water to make 500 mL of solution

4) What is the concentration of H\textsubscript{2}SO\textsubscript{4} if it takes 45.8 mL of 0.75 M NaOH to completely neutralize 25.00 mL of the H\textsubscript{2}SO\textsubscript{4}?

\[ \text{MV}_{H^+} = \text{MV}_{OH^-} \quad (M_{H^+})(0.025L) = (0.75\text{ M NaOH})(0.0458 \text{ L}) \]

\[ M_{H^+} = 1.374 \text{ M} \text{ H}^+ \text{ but there are } 2\text{H}^+ \text{ per H}_2\text{SO}_4 \text{ so } M = 0.687 \text{ M H}_2\text{SO}_4 \]
5) Describe how you would make 125 mL of 0.25 M KI solution.

\[ MV = \text{moles} \times (0.25M)(0.125L) = 0.03125 \text{ mole KI} \]

0.03125 mole KI x 166 g/mole KI = 5.1875 grams KI

so, place 5.1874 grams of KI into a container and add enough water to make 125 mL of solution

6) How would you make a 100 mL of 3 M HCl from concentrated HCl (12M)?

\[ M_1V_1 = M_2V_2 \]

\[ (3M)(0.100L) = (12M)(V_2) \]

\[ V_2 = 0.025 L = 25 \text{ mL of } 12M \text{ HCl} \]

So, take 25 mL of 12 M HCl and add enough water to make a total of 100 mL of solution.

7) It took 24.76 mL of 0.25 M NaOH to completely titrate 15 mL of an acid solution. What was the concentration of the acid solution?

\[ M_1V_1 = M_2V_2 \]

\[ (0.25M)(0.02476L) = (M_2)(0.015L) \]

\[ M_2 = 0.4127 \text{ M Acid} \]

8) It took 23.52 mL of 0.25 M NaOH to completely titrate 0.500 grams of an unknown acid. What is the molar mass of the unknown acid?

In a titration, moles H+ = moles OH-, also, MV = moles, so

\[ MV_{OH} = (0.25M)(0.02352L) = 0.00588 \text{ mole OH-} = 0.0058 \text{ mole H+} = \text{moles of acid} \]

molar mass = grams/moles so, 0.500 grams/0.0058 moles = 85.03 g/mol acid

9) Which of the following compounds has the highest boiling point?

This molecule H-bonds so it has the highest intermolecular forces and the highest BP.

10) Which of the following has the highest vapor pressure?

This molecule only has induced dipoles which are the weakest of the forces, therefore it will have the highest vapor pressure.