1. Water is added to 4.267 grams of UF$_6$. The only products are 3.730 grams of a solid containing only uranium, oxygen, and fluorine and 0.970 grams of a gas. The gas is 95% fluorine, and the remainder is hydrogen.
   a. From the data given, determine the empirical formula of the gas.
   b. What fraction of the fluorine from the original compound is in the solid and what fraction in the gas after the reaction?
   c. What is the formula of the solid product?
   d. Write a balanced chemical equation for the reaction between UF$_6$ and water. Assume that the empirical formula of the gas is the true formula.

2. Three volatile compounds X, Y, and Z each contain element Q. The percent by mass of element Q in each compound was determined. The data obtained are given below.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Percent (m/m) of element Q</th>
<th>Molecular mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>64.8%</td>
<td>88.1</td>
</tr>
<tr>
<td>Y</td>
<td>73.0%</td>
<td>104.</td>
</tr>
<tr>
<td>Z</td>
<td>59.3%</td>
<td>64.0</td>
</tr>
</tbody>
</table>

   a. Determine the mass of element Q contained in 1.00 mole of each of these compounds.
   b. Calculate the most probable value of the atomic mass of element Q.
   c. Compound Z contains carbon, hydrogen, and element Q. When 1.00 gram of compound Z is oxidized and all of the carbon and hydrogen are converted to oxides, 1.37 grams of CO$_2$ and 0.281 grams of water are produced. Determine the most probable molecular formula of compound Z.

3. The molecular formula of a hydrocarbon is to be determined by analyzing its combustion products and investigating its colligative properties.
   a. The hydrocarbon burns completely, producing 7.2 grams of water and 7.2 liters of CO$_2$ at standard conditions. What is the empirical formula of the hydrocarbon?
   b. Calculate the mass in grams of O$_2$ required for the complete combustion of the sample of the hydrocarbon described in part (a).
   c. The hydrocarbon dissolves readily in CHCl$_3$. The freezing point of a solution prepared by mixing 100. Grams of CHCl$_3$ and 0.600g of the hydrocarbon is -64.0°C. The molal freezing point depression constant of CHCl$_3$ is 4.68°C/molal and its normal freezing point is -63.5°C. Determine the molecular mass of the hydrocarbon.
   d. What is the molecular formula of the hydrocarbon?

4. An unknown compound contains only three elements: C, H, and O. A pure sample of the compound is analyzed and found to be 65.60% C and 9.44% H by mass.
   a. Determine the empirical formula of the compound.
   b. A solution of 1.570g of the compound in 16.08g of camphor is observed to freeze at a temperature 15.2°C lower than the normal freezing point of pure camphor. Determine the molar mass and apparent molecular formula of the compound. (The molal freezing point depression constant for camphor is 40.0 kg×K×mol$^{-1}$)
5. Answer the following questions about solid beryllium oxalate, \( \text{BeC}_2\text{O}_4 \) (s), and its hydrate.
   a. Calculate the mass percent of carbon in the hydrated form of the solid that has the formula \( \text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O} \).
   b. When heated to 220°C, \( \text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O} \) (s) decomposes completely, as shown below.
      \[
      \text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O} (s) \rightarrow \text{BeC}_2\text{O}_4 (s) + 3 \text{H}_2\text{O} (g)
      \]
      If 3.21g of \( \text{BeC}_2\text{O}_4 \cdot 3\text{H}_2\text{O} \) (s) is heated to 220°C, then calculate...
      i. the mass of \( \text{BeC}_2\text{O}_4 \) (s) formed
      ii. the volume that the water vapor produced would occupy at STP

6. The following reaction between iron and oxygen shows the formation of rust, aka iron(III) oxide.
   \[
   2 \text{Fe} (s) + 3/2 \text{O}_2 (g) \rightarrow \text{Fe}_2\text{O}_3 (s)
   \]
   A 115.0g sample of iron is mixed with 17.5L of \( \text{O}_2 \) (g) at STP.
   a. Calculate the moles of each reactant before the reaction begins.
   b. Identify the limiting reactant when the reaction is heated to produce \( \text{Fe}_2\text{O}_3 \). Show calculations to justify your answer.
   c. Calculate the number of moles of product produced when the reaction has completed.