1. For a mixture prepared by mixing 5.00 g of caffeine (C₈H₁₀N₄O₂) with 250.0 mL of water. The final density of this mixture is 1.05 g/mL.
   a. Calculate the boiling point of this mixture
   b. Calculate the freezing point of this mixture
   c. Calculate the osmotic pressure of this mixture at 25 °C.

2. Add 5.00 g NaCl to 500 ml H₂O. What is the freezing point? What is the boiling point? Assume that all of the NaCl dissociates in solution.

3. Note: Omit this problem. There is not enough information given to find a solution for part a or b.
   A solution is 6.00% by mass of a solute and the rest is water.
   a. Calculate the molar mass of the solute. Assume it is not an ionic compound.
   b. The density of the solution is 1.023 g/mL. Calculate the osmotic pressure of the solution.

4. The reaction

   $$2\text{N}_2\text{O}_5(g) \rightarrow 4\text{NO}_2(g) + \text{O}_2(g)$$

   a) For the reactant and each of the products write expressions for the rate of reaction.
   b) If oxygen is produced at a rate of $4.8 \times 10^{-3}$ mol L⁻¹ s⁻¹ at what rate is N₂O₅ disappearing and at what rate is NO₂ forming?
5. The rate of the reaction

\[ 2\text{HgCl}_2(\text{s}) + \text{C}_2\text{O}_4^{2-}(\text{aq}) \rightarrow 2\text{Cl}^-\text{(aq)} + 2\text{CO}_2(\text{g}) + \text{Hg}_2\text{Cl}_2(\text{s}) \]

is followed by measuring the initial rate at different concentrations of the reactants.

<table>
<thead>
<tr>
<th>Expt</th>
<th>[HgCl₂], M</th>
<th>[C₂O₄²⁻], M</th>
<th>Initial rate, mol/(L min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.105</td>
<td>0.15</td>
<td>1.8 x 10⁻⁵</td>
</tr>
<tr>
<td>2</td>
<td>0.105</td>
<td>0.30</td>
<td>7.1 x 10⁻⁵</td>
</tr>
<tr>
<td>3</td>
<td>0.052</td>
<td>0.30</td>
<td>3.5 x 10⁻⁵</td>
</tr>
<tr>
<td>4</td>
<td>0.052</td>
<td>0.15</td>
<td>8.9 x 10⁻⁶</td>
</tr>
</tbody>
</table>

a) Determine the order of the reaction with respect to HgCl₂, with respect to C₂O₄²⁻, and overall.
b) Write the rate law for this reaction.
c) What is the value of the rate constant \(k\)?
d) What would be the initial rate of reaction if [HgCl₂] = 0.020 M and [C₂O₄²⁻] = 0.22 M?

6. The following reaction is first order with a rate constant of 6.2 x 10⁻⁴ s⁻¹ at 45°C.

\[ \text{N}_2\text{O}_5 \rightarrow \text{N}_2\text{O}_4 + \frac{1}{2}\text{O}_2 \]

If an initial amount of 80.0 g of N₂O₅ is allowed to decompose at 45°C......
a. How long will it take for the quantity of N₂O₅ to be reduced to 2.5 g?
b. What volume of O₂ at 1 atm and 45°C will be produced at this point?

7. Textbook Chapter 13 Problem 54