1. Use the data in Table A1.2 to determine the entropy per mole of \( \text{N}_2(g) \) at 0 °C and 0.10 bar pressure. Assume that nitrogen is an ideal gas.

2.a) Calculate \( \Delta S^\circ \) for the following reaction at 298 K.

\[
2 \text{H}_2(g) + \text{O}_2(g) = 2 \text{H}_2\text{O}(l)
\]

b) The value obtained in Part (a) is very negative. Yet, we know that if we mix hydrogen and oxygen under standard conditions that a spark will set off an explosive reaction. To see how this can be reconciled with the second law of thermodynamics, calculate the entropy change for the surroundings and show that \( \Delta S^{\circ}_{\text{system}} + \Delta S^{\circ}_{\text{surroundings}} > 0 \). To perform this calculation assume that the heat given off by the reaction is heat input to the surroundings reversibly at 298 K.

c) Now, calculate \( \Delta S^\circ \) for the following reaction at 298 K.

\[
2 \text{H}_2(g) + \text{O}_2(g) = 2 \text{H}_2\text{O}(g)
\]

Use your general knowledge of entropy to answer each of the following questions:

i) Why is \( \Delta S^\circ \) less negative for this reaction than for the reaction in part (a)?

ii) Why is \( \Delta S^\circ \) less than zero for this reaction?

3. Use the following data for enthalpies of fusion, fusion temperatures (melting points), enthalpies of vaporization, and vaporization temperatures (boiling points) to answer the questions below.

<table>
<thead>
<tr>
<th>Compound</th>
<th>( T_f/K )</th>
<th>( \Delta H_{\text{fus}}^\circ / \text{kJ mol}^{-1} )</th>
<th>( T_b/K )</th>
<th>( \Delta H_{\text{vap}}^\circ / \text{kJ mol}^{-1} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{C}_2\text{H}_6 )</td>
<td>89.85</td>
<td>2.86</td>
<td>184.6</td>
<td>14.7</td>
</tr>
<tr>
<td>( \text{C}_6\text{H}_6 )</td>
<td>278.6</td>
<td>10.59</td>
<td>353.2</td>
<td>30.8</td>
</tr>
<tr>
<td>( \text{CH}_3\text{OH} )</td>
<td>175.2</td>
<td>3.16</td>
<td>337.2</td>
<td>35.27</td>
</tr>
<tr>
<td>( \text{Cl}_2 )</td>
<td>172.1</td>
<td>6.41</td>
<td>239.1</td>
<td>20.41</td>
</tr>
</tbody>
</table>

a) Determine the entropies of vaporization and compare the results to the Trouton Rule. Suggest a reason for the very large value of one of the entropies of vaporization.

b) Determine the entropies of fusion and compare them to the entropies of vaporization for the same compounds. What can one conclude from this comparison about the relative size of entropies of fusion and entropies of vaporization.