**Question 1**

\[
\text{Na}_2\text{S}_2\text{O}_3(aq) + 4 \text{NaOCl}(aq) + 2 \text{NaOH}(aq) \rightarrow 2 \text{Na}_2\text{SO}_4(aq) + 4 \text{NaCl}(aq) + \text{H}_2\text{O}(l)
\]

A student performs an experiment to determine the value of the enthalpy change, \(\Delta H_{rxn}^{\circ}\), for the oxidation-reduction reaction represented by the balanced equation above.

(a) Determine the oxidation number of Cl in NaOCl.

| +1 | 1 point is earned for the correct answer. |

(b) Calculate the number of grams of Na\(_2\)S\(_2\)O\(_3\) needed to prepare 100.00 mL of 0.500 \(M\) Na\(_2\)S\(_2\)O\(_3\)(aq).

\[
100.00 \text{ mL} \times \frac{0.500 \text{ mol Na}_2\text{S}_2\text{O}_3}{1000 \text{ mL}} \times \frac{158.10 \text{ g Na}_2\text{S}_2\text{O}_3}{1 \text{ mol Na}_2\text{S}_2\text{O}_3} = 7.90 \text{ g Na}_2\text{S}_2\text{O}_3
\]

1 point is earned for the correct number of moles of Na\(_2\)S\(_2\)O\(_3\) (may be implicit).

1 point is earned for the correct calculation of mass of Na\(_2\)S\(_2\)O\(_3\) consistent with the number of moles.

In the experiment, the student uses the solutions shown in the table below.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Concentration ((M))</th>
<th>Volume ((\text{mL}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na(_2)S(_2)O(_3)(aq)</td>
<td>0.500</td>
<td>5.00</td>
</tr>
<tr>
<td>NaOCl(aq)</td>
<td>0.500</td>
<td>5.00</td>
</tr>
<tr>
<td>NaOH(aq)</td>
<td>0.500</td>
<td>5.00</td>
</tr>
</tbody>
</table>

(c) Using the balanced equation for the oxidation-reduction reaction and the information in the table above, determine which reactant is the limiting reactant. Justify your answer.

NaOCl is the limiting reactant.

Given that equal numbers of moles of each reactant were present initially, it follows from the coefficients of the reactants in the balanced equation that NaOCl will be depleted first.

1 point is earned for identifying the limiting reactant and providing a valid justification.