1. \(2 \text{S}_2\text{O}_3^{2−} (aq) + \text{I}_2 (aq) \rightarrow \text{S}_4\text{O}_6^{2−} (aq) + 2 \text{I}^{−} (aq)\)

In an experiment, 0.0080 mol \(\text{S}_2\text{O}_3^{2−}\) is consumed in 2.0 L of solution each second. What is the rate of consumption of \(\text{I}_2\)? At what rates are \(\text{S}_4\text{O}_6^{2−}\) and \(\text{I}^{−}\) produced in the solution?

\[
\text{Rate (S}_2\text{O}_3^{2−}) = \frac{-\Delta [\text{S}_2\text{O}_3^{2−}]}{\Delta t} = \frac{-0.0080 \text{ mol}/2.0 \text{ L}}{1 \text{ s}} = -0.0040 \text{ M/s}
\]

\[
\text{Rate (I}^{−}) = \frac{-0.0040 \text{ M (S}_2\text{O}_3^{2−})}{1 \text{ s}} \times \frac{1 \text{ I}_2}{2 \text{ S}_2\text{O}_3^{2−}} = -0.0020 \text{ M/s}
\]

Rate if appearance of \(\text{S}_4\text{O}_6^{2−}\) will equal the rate of disappearance of \(\text{I}_2\) (1:1 mole ratio)

\[
\text{Rate (S}_4\text{O}_6^{2−}) = +0.0020 \text{ M/s}
\]

Rate of appearance of \(\text{I}^{−}\) will equal the rate of disappearance of \(\text{S}_2\text{O}_3^{2−}\) (1:1 mole ratio)

\[
\text{Rate (I}^{−}) = +0.0040 \text{ M/s}
\]

2. Given the following data, determine the rate law for the reaction.

\[
\text{NH}_4^{+} (aq) + \text{NO}_2^{−} (aq) \rightarrow \text{N}_2 (g) + 2 \text{H}_2\text{O} (l)
\]

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial Concentration of NH$_4^+$</th>
<th>Initial Concentration of NO$_2^-$</th>
<th>Initial Rate (mol/L·s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.100 M</td>
<td>0.0050 M</td>
<td>$1.35 \times 10^{-7}$</td>
</tr>
<tr>
<td>2</td>
<td>0.100 M</td>
<td>0.010 M</td>
<td>$2.70 \times 10^{-7}$</td>
</tr>
<tr>
<td>3</td>
<td>0.200 M</td>
<td>0.010 M</td>
<td>$5.40 \times 10^{-7}$</td>
</tr>
</tbody>
</table>

Compare Expts. 1 and 2.
Rate \(\alpha [\text{NO}_2^{−}]^x\)

The rate doubles when the concentration is doubled.

\[
2 = 2^x
\]

\[
x = 1
\]

Compare Expts. 2 and 3.
Rate \(\alpha [\text{NH}_4^{+}]^y\)

The rate doubles when the concentration is doubled.

\[
2 = 2^y
\]

\[
y = 1
\]

Rate = \(k[\text{NH}_4^{+}][\text{NO}_2^{−}]\)
3. Given the following data, determine the rate law for the reaction.

\[
\text{BrO}_3^- (aq) + 5 \text{Br}^- (aq) + 6 \text{H}^+ (aq) \rightarrow 3 \text{Br}_2 (l) + 3 \text{H}_2\text{O} (l)
\]

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial Concentration of BrO(_3^-)</th>
<th>Initial Concentration of Br(^-)</th>
<th>Initial Concentration of H(^+)</th>
<th>Initial Rate (mol/L(\cdot)s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.10 M</td>
<td>0.10 M</td>
<td>0.10 M</td>
<td>8.0 \times 10^{-4}</td>
</tr>
<tr>
<td>2</td>
<td>0.20 M</td>
<td>0.10 M</td>
<td>0.10 M</td>
<td>1.6 \times 10^{-3}</td>
</tr>
<tr>
<td>3</td>
<td>0.20 M</td>
<td>0.20 M</td>
<td>0.10 M</td>
<td>3.2 \times 10^{-3}</td>
</tr>
<tr>
<td>4</td>
<td>0.10 M</td>
<td>0.10 M</td>
<td>0.20 M</td>
<td>3.2 \times 10^{-3}</td>
</tr>
</tbody>
</table>

Compare Expts. 1 and 2.
Rate \(\alpha [\text{BrO}_3^-]^x\)
The rate doubles when the concentration is doubled.
\[2 = 2^x\]
x = 1

Compare Expts. 2 and 3.
Rate \(\alpha [\text{Br}^-]^y\)
The rate doubles when the concentration is doubled.
\[2 = 2^y\]
y = 1

Compare Expts. 1 and 4.
Rate \(\alpha [\text{H}^+]^z\)
The rate quadruples when the concentration is doubled.
\[4 = 2^z\]
z = 2

\[
\text{Rate} = k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2
\]