1. Examine the following reaction mechanism:

Step 1: \( \text{OCl}^- + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{OH}^- \)
Step 2: \( \text{HOCl} + \text{I}^- \rightarrow \text{HOI} + \text{Cl}^- \)
Step 3: \( \text{HOI} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{O}^- \)

(a) Identify the catalyst in the mechanism and explain how you were able to make your identification. \( \text{H}_2\text{O} \) is used up in step 1 but regenerated in step 3.

(b) Explain why \( \text{OH}^- \) would be called a reaction intermediate.

(c) List any additional reaction intermediates.

\( \text{HOCl}, \text{HOI} \)

2. The reaction between \( \text{NO}_2 \) and \( \text{CO} \) is slow and has the overall equation:

\( \text{NO}_2(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{CO}_2(\text{g}) \)

One step in the two-step mechanism of this reaction is:

\( \text{CO}(\text{g}) + \text{NO}_3(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{CO}_2(\text{g}) \quad \text{FAST} \)

(a) Write the equation for the other step in the mechanism.

\( \text{NO}_2 + \text{NO}_2 \rightarrow \text{NO} + \text{NO}_3 \)

(b) State whether your proposed step is slow or fast and explain your choice.

Slow, the overall reaction is slow and the other step is fast.

3. The proposed mechanism for a reaction is:

Step 1: \( \text{CH}_3\text{OH} + \text{HCl} \rightarrow \text{CH}_3^+ + \text{H}_2\text{O} + \text{Cl}^- \)
Step 2: \( \text{CH}_3^+ + \text{Cl}^- \rightarrow \text{CH}_3\text{Cl} \)

(a) What is the overall reaction being studied?

\( \text{CH}_3\text{OH} + \text{HCl} \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{Cl} \)

(b) List any reaction intermediates.

\( \text{CH}_3^+, \text{Cl}^- \)

4. The proposed mechanism for a reaction is:

Step 1: \( \text{NO}_2\text{Cl} \rightarrow \text{NO}_2 + \text{Cl} \quad \text{slow} \)
Step 2: \( \text{NO}_2\text{Cl} + \text{Cl} \rightarrow \text{NO}_2 + \text{Cl}_2 \quad \text{fast} \)

(a) Describe the overall reaction.

\( 2\text{NO}_2\text{Cl} \rightarrow 2\text{NO}_2 + \text{Cl}_2 \quad \text{slow} \)
5. Consider the following fast reaction:

\[ H^+ + I^- + H_2O_2 \rightarrow H_2O + HOI \]

A student proposes the following two-step mechanism for the above fast reaction:

Step 1: \[ H^+ + H^+ + H_2O_2 \rightarrow H_4O_2^{2+} \]
Step 2: \[ H_4O_2^{2+} + I^- \rightarrow H_2O + HOI + H^+ \]

Would you agree or disagree with the proposed mechanism? Explain.

6. Consider the following reaction:

\[ CO + NO_2 \rightarrow CO_2 + NO \]

(a) The first step in each of two proposed reaction mechanisms for the above reaction is listed below. If each proposed reaction mechanism consists of only two steps, determine the second step for each mechanism.

**proposed mechanism one:**

Step 1: \[ 2NO_2 \rightarrow NO_3 + NO \] SLOW
Step 2: \[ CO + NO_3 \rightarrow NO_2 + CO_2 \] FAST

**proposed mechanism two:**

Step 1: \[ 2NO_2 \rightarrow N_2O_4 \] FAST
Step 2: \[ N_2O_4 + CO \rightarrow CO_2 + NO + NO_2 \] SLOW

(b) Experimental data shows that the rate of the reaction is not affected by a change in the CO concentration. Which of the two proposed reaction mechanisms would be consistent with the data? Explain. The first mechanism, CO is not a reactant in the rate determining step of this mechanism.

7. Consider the following reaction mechanism:

Step 1: \[ NO_2 + Mn \rightarrow NO_2Mn \]
Step 2: \[ NO_2Mn + NO_2 \rightarrow NO_3 + NO + Mn \]
Step 3: \[ NO_3 + CO \rightarrow NO_2 + CO_2 \]

(a) Identify the catalyst. \[ Mn, NO_2 \]
(b) Identify a reaction intermediate. \[ NO_2Mn, NO_3 \]
(c) Identify the products of the overall reaction. \[ NO, CO_2 \]