1. Consider the reaction:
   \[ \text{CaCO}_3(s) + 2 \text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g) \]
   Which action is the most likely to increase the rate at which carbon dioxide gas forms?
   a. grinding the chalk (source of calcium carbonate) into a fine powder
   b. using nitric acid rather than hydrochloric acid
   c. allowing the carbon dioxide to escape from the container as soon as it is formed
   d. both provide the same effect

2. Which statement is true?
   a. A material that is inert (unreactive) under one set of circumstances will be inert under all circumstances.
   b. A catalyst is a substance that increases the rate of reaction without interacting with the reactants.
   c. It is likely that the combustion of octane, \( \text{C}_8\text{H}_{18} \), takes place by a concerted (one-step) mechanism.
   d. Water will evaporate more quickly from a shallow pool than from a deep well.

3. A proposed mechanism for the reaction of chlorine with hydrogen sulfide in aqueous solution is shown below:
   \[ \text{HS}^- + \text{Cl}_2 \rightarrow 2 \text{Cl}^- + \text{S} + \text{H}^+ \]
   \[ \text{H}_2\text{S} = \text{HS}^- + \text{H}^+ \]
   What does this mechanism predict about the relationship of pH and the rate of the reaction?
   a. Changes in pH should have no effect on the rate of reaction.
   b. Raising the pH one unit should decrease the rate of reaction by a factor of 10.
   c. Raising the pH one unit should increase the rate of reaction by a factor of 10.
   d. Raising the pH one unit should decrease the rate of reaction by a factor of 100.

4. Which data, given below, indicates that the order of a reaction with respect to a reactant, A, is zero?
   a. A plot of [A] versus time looks like a straight line, sloping down.
   b. A plot of \( \ln[A] \) versus time looks like a straight line, sloping down.
   c. The rate of reaction is 0.002 mol/(L-s) when [A] = 0.50 M in one reaction mixture and 0.004 mol/(L-s) when [A] = 1.0 M in another.
   d. The reaction consumes half of the remaining A every 10 seconds.
5. Which statement about the destruction of ozone (O₃) by reaction with NO should be correct, according to the mechanism shown below?

\[
\text{NO} + \text{NO} = \text{N}_2\text{O}_3 + \text{heat}\quad \text{rapid equilibration}
\]
\[
\text{N}_2\text{O}_3 + \text{O}_3 \rightarrow \text{NO} + \text{NO}_2 + \text{O}_2 \quad \text{slow}
\]

\(a\). The rate of consumption of ozone (O₃) should decrease as the temperature is increased.
\(b\). A build up of NO₂ should increase the rate of destruction of ozone.
\(c\). A doubling in NO concentration should increase the rate of destruction of ozone by a factor of two.
\(d\). N₂O₃ is a catalyst for the destruction of ozone.

6. An equilibrium constant can be regarded as the ratio of the rate constants for a forward reaction and its reverse. Why is it that the coefficients of the balanced equation are the powers in the equilibrium constant but the coefficients are not necessarily the orders of the reaction?

\(a\). Every step in a mechanism contributes equally to the rate expression. Only some steps figure into the equilibrium expression. \(\text{must be opposite is true}\)
\(b\). A reaction can't reach equilibrium unless all steps leading to the overall change are reversible. The rate expression may reflect the kinetics of a single slow step.
\(c\). Equilibrium and kinetics are unrelated. For example, the direct synthesis of ammonia from nitrogen and hydrogen is favored by thermodynamics but disfavored by kinetics.
\(d\). Orders can be negative or fractional. Powers are always positive integers.

7. The oxidation of Fe²⁺ by Ce⁴⁺ was studied by the Method of Initial Rates. What is the rate expression for this reaction as described by the data given below?

<table>
<thead>
<tr>
<th>[Ce⁴⁺], mol/L</th>
<th>[Fe²⁺], mol/L</th>
<th>Initial Rate, mol/(L·sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1×10⁻⁵</td>
<td>1.8×10⁻⁵</td>
<td>2.0×10⁻⁷</td>
</tr>
<tr>
<td>1.1×10⁻⁵</td>
<td>2.8×10⁻⁵</td>
<td>3.1×10⁻⁷</td>
</tr>
<tr>
<td>3.4×10⁻⁵</td>
<td>2.8×10⁻⁵</td>
<td>9.5×10⁻⁷</td>
</tr>
</tbody>
</table>

\(a\). Rate = k[Ce⁴⁺][Fe²⁺]
\(b\). Rate = k[Ce⁴⁺]²[Fe²⁺]
\(c\). Rate = k[Ce⁴⁺][Fe²⁺]²
\(d\). Rate = k[Ce⁴⁺]²[Fe²⁺]²