Introduction to Kinetics: Factors That Affect the Rate of Reaction

Determining the Rate Law:
A Kinetics Study of the Iodination of Acetone

Objectives:
1. Be able to list and rationalize the factors that affect the rate of reaction.
2. Explain various scenarios using the factors that affect reaction kinetics.
3. Gain a quantitative understanding of kinetics.
4. Determine the rate of a reaction, the order of the reaction with respect to the reactants and the value of the rate constant.
5. Predict reaction times using an experimentally rate law.

The Rate Law:

\[ aA + bB \rightarrow cC + dD \]

Reaction Rate: \( V = k[A]^m[B]^n \)

\( m \) and \( n \) are determined by the experiments.

A. Effect of Changing the Concentration of Reactants:
- Solid: Effect of Changing the Surface Area
- Gas: Pressure of the Gas
- Liquid: Concentration of the Solution
- Solution: Concentration of the Solution

B. Effect of Changing the Temperature:

C. Effect of Adding a Catalyst:

<table>
<thead>
<tr>
<th>Career</th>
<th>Application</th>
<th>Fast or slow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biologist</td>
<td>Preservation or decomposition of specimens</td>
<td></td>
</tr>
<tr>
<td>Chemical Engineer</td>
<td>Speed of production affecting cost</td>
<td></td>
</tr>
<tr>
<td>Civil Engineer</td>
<td>Concrete and asphalt curing</td>
<td></td>
</tr>
<tr>
<td>Doctor</td>
<td>Medication or poison affecting the body</td>
<td></td>
</tr>
<tr>
<td>Museum Curator</td>
<td>Dating, restoration, preservation of artifacts</td>
<td></td>
</tr>
<tr>
<td>Restaurant Owner</td>
<td>Food quality and safety</td>
<td></td>
</tr>
<tr>
<td>Computer Engineer</td>
<td>Speed of calculation</td>
<td></td>
</tr>
</tbody>
</table>
**Introduction to Kinetics:**
Factors That Affect the Rate of Reaction

**Procedure:**

- **Part A:** Effect of Changing the Concentration of Reactants
  - 1M HCl
  - 6M HCl

- **Part B:** Effect of Changing the Surface Area
  - CuSO₄ 10 ml

- **Part C:** Effect of Changing the Temperature
  - Ice Bath
  - 80 °C

- **Part E:** Effect of Adding a Catalyst
  - Decomposing of H₂O₂
  - 10 ml 6%H₂O₂
  - 0.05 g KI

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The Rate Law:

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Reaction Rate: \[ V = k[A]^m[B]^n \]

m and n are determined by the experiments.
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The Iodination of Acetone:
\[
\text{CH}_3\text{COCH}_3(\text{aq}) + I_2(\text{aq}) \rightarrow \text{CH}_3\text{COCH}_2I(\text{aq}) + H^+(\text{aq}) + I^-(\text{aq})
\]

Yellow clorless

\[

v = \frac{-\Delta[I_2]}{\Delta t} = - \frac{[I_2]_{\text{final}} - [I_2]_{\text{initial}}}{\Delta t}
\]

\[

\text{Procedure:}
\begin{align*}
1. & \text{Clean the glassware.} \\
 & \text{soap} \rightarrow \text{water} \rightarrow \text{de-ionized water} \rightarrow \text{rinse with solution}
\end{align*}
\]

\[

\text{Procedure:}
\begin{align*}
2. & \text{Prepare a blank.} \\
 & 50 \text{ mL of water in 250-mL Erlenmeyer flask}
\end{align*}
\]

\[

\text{Procedure:}
\begin{align*}
3. & \text{Prepare a mixture without } I_2. \\
 & 10 \text{ mL acetone} \quad 10 \text{ mL HCl} \quad 20 \text{ mL DI water}
\end{align*}
\]

\[

\text{Procedure:}
\begin{align*}
4. & \text{Add } I_2 \text{ and start the timer.} \\
 & a. \text{ I}_2 \text{ is added quickly with stirring} \\
 & b. \text{ Record the time when the color} \\
 & \text{of the solution changed from yellow} \\
 & \text{to colorless} \\
 & c. \text{ Record the volumes of all chemicals}
\end{align*}
\]

\[

\text{Procedure:}
\begin{align*}
5. & \text{Repeat steps 3 and 4.} \\
 & a. \text{ Calculate the percent difference} \\
 & \text{between two times.} \\
 & b. \text{ Repeat until the percent difference} \\
 & \text{is less than 5%}.
\end{align*}
\]
Determining the Rate Law: A Kinetics Study of the Iodination of Acetone

Procedure:
6. How to determine the order with respect to Acetone. Make your proposal, and show it to your instructor.

<table>
<thead>
<tr>
<th></th>
<th>4 M acetone</th>
<th>H₂O</th>
<th>1 M HCl</th>
<th>0.00118 M I₂</th>
<th>Total Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.0</td>
<td>20.0</td>
<td>10.0</td>
<td>10.0</td>
<td>50.0</td>
</tr>
<tr>
<td>2</td>
<td>?</td>
<td>?</td>
<td>10.0</td>
<td>?</td>
<td>50.0</td>
</tr>
<tr>
<td>3</td>
<td>?</td>
<td>?</td>
<td>10.0</td>
<td>?</td>
<td>50.0</td>
</tr>
<tr>
<td>4</td>
<td>? (not used above)</td>
<td>?</td>
<td>10.0</td>
<td>? (not used above)</td>
<td>50.0</td>
</tr>
</tbody>
</table>