CHAPTER 13  KINETICS  (REACTION RATES)

reaction rates \[ \frac{\Delta [\text{A}]}{\Delta t} \]

A \rightarrow \text{B as time goes by} \ [\text{A}] \rightarrow [\text{B}] \uparrow

"average" rate \( \frac{\Delta [\text{A}]}{\Delta t} = \frac{\Delta [\text{B}]}{\Delta t} \)

the rate is changing as time goes by

\[ \rightarrow \text{if the time interval shrinks to a single point} \Rightarrow \text{line = tangent} \]

slope of tangent = "instantaneous" rate

\[ \left( \frac{d[\text{A}]}{dt} \right) \]
CHAPTER 13  KINETICS  (REACTION RATES)

reaction rates \( \frac{\Delta C}{\Delta t} \)

\[ A \rightarrow B \text{ as time goes by } [A] \downarrow [B] \uparrow \]

"average" rate \( = - \frac{\Delta [A]}{\Delta t} = \frac{\Delta [B]}{\Delta t} \)

The rate is changing as time goes by

\( \rightarrow \) if the time interval shrinks to a single point \( \Rightarrow \) line = tangent

slope of tangent \( \Rightarrow "\text{instantaneous" rate} \)

\( \frac{d[C]}{dt} \)
\[ aA + bB \rightarrow cC + dD \]

**Rate Law**

\[
\text{rate} = k [A]^{a} [B]^{b}
\]

- **rate constant**
- **independent**
- **orders of the reaction**
- **"orders" of the reaction must be determined**
- **T dependent** experimentally (for an overall reaction)

\[
\text{average rate} = -\frac{1}{a} \frac{\Delta [A]}{\Delta t} = -\frac{1}{b} \frac{\Delta [B]}{\Delta t} = \frac{1}{c} \frac{\Delta [C]}{\Delta t} = \frac{1}{d} \frac{\Delta [D]}{\Delta t}
\]

\[ 4 \text{NH}_3(g) + 5 \text{O}_2(g) \rightarrow 4 \text{NO}(g) + 6 \text{H}_2\text{O}(g) \]

\[
\text{"average rate"} = -\frac{1}{4} \frac{\Delta [\text{NH}_3]}{\Delta t} = \frac{1}{6} \frac{\Delta [\text{H}_2\text{O}]}{\Delta t}
\]

**Instantaneous rate**

\[
\text{rate} = k [\text{NH}_3]^a [\text{O}_2]^b
\]

**Overall Rate**

<table>
<thead>
<tr>
<th>Order</th>
<th>K Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>( \text{M} \text{s}^{-1} )</td>
</tr>
<tr>
<td>1</td>
<td>( \text{s}^{-1} )</td>
</tr>
<tr>
<td>2</td>
<td>( \text{M}^{-2} \text{s}^{-1} )</td>
</tr>
<tr>
<td>3</td>
<td>( \text{M}^{-3} \text{s}^{-1} )</td>
</tr>
<tr>
<td>4</td>
<td>( \text{M}^{-4} \text{s}^{-1} )</td>
</tr>
<tr>
<td>5</td>
<td>( \text{M}^{-5} \text{s}^{-1} )</td>
</tr>
</tbody>
</table>

**Rate Unit**

\[
\text{rate} \Rightarrow \frac{\text{M}}{\text{time}} = \frac{\text{Mol}}{\text{L \text{s}}} = \text{Mol L}^{-1} \text{s}^{-1}
\]