Problem #1

The decomposition of hydrogen peroxide, H$_2$O$_2$, can be represented by the following reaction:

\[ 2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) \]

The table below reports data taken at room temperature (300 K).

Table 1. Decomposition of H$_2$O$_2$(aq) at 300 K.

<table>
<thead>
<tr>
<th>concH$_2$O$_2$ (mol/liter)</th>
<th>time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.32</td>
<td>0</td>
</tr>
<tr>
<td>2.01</td>
<td>200</td>
</tr>
<tr>
<td>1.72</td>
<td>400</td>
</tr>
<tr>
<td>1.49</td>
<td>600</td>
</tr>
<tr>
<td>0.98</td>
<td>1200</td>
</tr>
<tr>
<td>0.62</td>
<td>1800</td>
</tr>
<tr>
<td>0.25</td>
<td>3000</td>
</tr>
</tbody>
</table>

(a) Show that the reaction is first order.

(b) Calculate the value of the half-life of this reaction.

(c) Suppose that the initial concentration of H$_2$O$_2$ were 3.5 M. How long would it take at 300 K to reduce the concentration of H$_2$O$_2$ to 25% of its initial value?

Problem #2

A chemical reaction which has an activation energy of 167.0 kJ/mole is to proceed at $T = 450$ K with a very constant rate; the rate is allowed to vary at most by $\pm 1\%$. How constant must the temperature be to achieve this required rate stability? (For $T\gg \Delta T$, $T_1 \times T_2 = T^2$)

Problem #3

Determine the diffusivity (D) of lithium (Li) in silicon (Si) at 1200°C, knowing that $D_{1100°C} = 10^{-5}$ cm$^2$/s and $D_{695°C} = 10^{-6}$ cm$^2$/s.

Problem #4

For a chemical reaction, the concentrations of reactant as a function of time are given below for 25°C and for 50°C.
(a) Indicate schematically (in two different graphic presentations) how you could prove, given concentration data at certain times, that a reaction is of first order.

(b) Determine, from graphic presentations, the rate constants \(k\) for the given reaction at 25°C and 50°C.

(c) Determine the half-life \(t_{1/2}\) for the reaction at 50°C.

(d) Determine the half-life \(t_{1/2}\) for the reaction at 70°C.

(e) What is the time required for the reaction at 25°C to be completed to the extent of 42%?

**Problem #5**

In a chemical reaction the concentration of a rate determining component is measured (in moles) at one minute intervals from zero to 5 minutes. The data are: 

\[1.0 \times 10^{-2}, 0.683 \times 10^{-2}, 0.518 \times 10^{-2}, 0.418 \times 10^{-2}, 0.350 \times 10^{-2} \text{ and } 0.301 \times 10^{-2}\]

(a) Determine the order \(n\) of this reaction.

(b) Determine the rate constant \(k\).

(c) Determine the half-life of this reaction.