1) 1.00 ml of a 0.005 M potassium thiosulfate (K_2S_2O_3) solution is added to a reaction vessel that contains KI and K_2S_2O_8. The following two reactions will occur:

1) K_2S_2O_8 + 2 KI → I_2 + 2 K_2SO_4
2) I_2 + 2 K_2S_2O_3 → 2 KI + K_2S_2O_6

How many moles of KI and K_2S_2O_8 will have been consumed at the point when all of the thiosulfate is consumed?

Thiosulfate in reaction 2 consumes I_2 produced by reaction of KI and K_2S_2O_8 in reaction 1.

(1.00 ml)*(1 L/1000 ml)* 0.005 M = 5.0x10^{-6} moles thiosulfate (K_2S_2O_3) in solution.

5.0x10^{-6} moles thiosulfate (K_2S_2O_3)*(1 mole I_2/ 2 mole K_2S_2O_3) = 2.5x10^{-6} moles I_2

2.5x10^{-6} moles I_2*(2 mole KI/ 1 mole I_2) = 5.0x10^{-6} moles KI consumed.

2.5x10^{-6} moles I_2*(1 mole K_2S_2O_8/ 1 mole I_2) = 2.5x10^{-6} moles K_2S_2O_8 consumed.

The same stoichiometric relationships will also be used to determine rates as \[\Delta [KI], \Delta [K_2S_2O_3] \text{ and } \Delta [K_2S_2O_8] \text{ will change according to the same ratios.}

2) For the reaction 2 NO + O_2 → 2 NO_2 the following initial rate data was collected.

<table>
<thead>
<tr>
<th>[NO]</th>
<th>[O_2]</th>
<th>Initial Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0126 M</td>
<td>0.0125 M</td>
<td>1.41x10^{-2} M/sec</td>
</tr>
<tr>
<td>0.0252 M</td>
<td>0.0250 M</td>
<td>1.13x10^{-1} M/sec</td>
</tr>
<tr>
<td>0.0252 M</td>
<td>0.0125 M</td>
<td>5.64x10^{-2} M/sec</td>
</tr>
</tbody>
</table>

What is the order of reaction for each reactant?
What are the units of the rate constant?
What is the value of the rate constant?

The rate law will have the form: Rate = k [NO]^m [O_2]^n
We can ratio sets of data to determine m & n.

Ratio sets 1 & 3 to find m.

\[
\begin{align*}
1.41x10^{-2} \text{ M/sec} &= k[0.0126]^m[0.0125]^n \\
5.64x10^{-2} \text{ M/sec} &= k[0.0252]^m[0.0125]^n \\
\end{align*}
\]

Cancel out where possible to get \(1/4 = (1/2)^m\), \(m = 2\)

Ratio sets 2 & 3 to find m.

\[
\begin{align*}
1.13x10^{-1} \text{ M/sec} &= k[0.0252]^m[0.0250]^n \\
5.64x10^{-2} \text{ M/sec} &= k[0.0252]^m[0.0125]^n \\
\end{align*}
\]

Cancel out where possible to get \(2 = (2)^n\), \(n = 1\)

The rate law is: Rate = k [NO]^2 [O_2]^1

K will have units of M^{-2}sec^{-1} because the rate always has units of M/sec.

Use all three sets of data to solve for k.

\[
\begin{align*}
1.41x10^{-2} \text{ M/sec} &= k[0.0126]^2[0.0125]^1 \\
1.13x10^{-1} \text{ M/sec} &= k[0.0252]^2[0.0250]^1 \\
5.64x10^{-2} \text{ M/sec} &= k[0.0252]^2[0.0125]^1 \\
\end{align*}
\]

The average rate constant \(k = 7109 \text{ M}^{-2}\text{sec}^{-1}\)
3) The following data was collected for a reaction

<table>
<thead>
<tr>
<th>T(°C)</th>
<th>k (M⁻¹ sec⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>0.0521</td>
</tr>
<tr>
<td>25</td>
<td>0.101</td>
</tr>
<tr>
<td>35</td>
<td>0.184</td>
</tr>
<tr>
<td>45</td>
<td>0.332</td>
</tr>
</tbody>
</table>

What is the value of the activation energy (Eₐ)?
What is the value of the frequency factor (A)?
Show all work.

<table>
<thead>
<tr>
<th>T(°C)</th>
<th>T(K)</th>
<th>1/T(K)</th>
<th>k</th>
<th>ln(k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>288</td>
<td>0.0035</td>
<td>0.0521</td>
<td>-2.9546</td>
</tr>
<tr>
<td>25</td>
<td>298</td>
<td>0.0034</td>
<td>0.1010</td>
<td>-2.2926</td>
</tr>
<tr>
<td>35</td>
<td>308</td>
<td>0.0032</td>
<td>0.1840</td>
<td>-1.6928</td>
</tr>
<tr>
<td>45</td>
<td>318</td>
<td>0.0031</td>
<td>0.3320</td>
<td>-1.1026</td>
</tr>
</tbody>
</table>

Slope = -5638.3
Eₐ = Slope * -R = 46876 J = 46.9 kJ

ln(A) = 16.623
A = e^{16.623} = 1.66x10⁷