Rate Law Worksheet

1. The rate of a reaction is given by \( k [A][B] \). The reactants are gases. If the volume occupied by the reacting gases is suddenly reduced to one-fourth the original volume, the rate of reaction (relative to the original rate) will be:

2. The following data are for Questions 2 through 8 and refer to the reaction:

\[ A + 2B + 3C \rightarrow 2Y + Z. \] All data were taken at 50.0°C.

<table>
<thead>
<tr>
<th>trial</th>
<th>initial [A]</th>
<th>initial [B]</th>
<th>initial [C]</th>
<th>rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>0.10</td>
<td>0.02</td>
<td>0.04</td>
<td>10 M/hr</td>
</tr>
<tr>
<td>#2</td>
<td>0.10</td>
<td>0.03</td>
<td>0.04</td>
<td>15 M/hr</td>
</tr>
<tr>
<td>#3</td>
<td>0.20</td>
<td>0.02</td>
<td>0.08</td>
<td>80 M/hr</td>
</tr>
<tr>
<td>#4</td>
<td>0.20</td>
<td>0.02</td>
<td>0.16</td>
<td>160 M/hr</td>
</tr>
<tr>
<td>#5</td>
<td>0.05</td>
<td>0.01</td>
<td>0.08</td>
<td>?</td>
</tr>
</tbody>
</table>

a. Doubling [B] would change the rate of formation Y by a factor of:

b. The rate of formation of Z in trial 3 was ________.

c. The rate of disappearance of C in trial 2 was ________.

d. The rate law derived for the reaction from the above data is ________.

e. The missing rate (trial 5) in units of M/hr should be:

f. The value of the specific rate constant is ________.

g. After a long time (assuming there is no reverse reaction), the concentration of Z in trial 3 would be ________.

3. What are the 2 ways in which a catalyst can affect a reaction?

4. How are homogenous and heterogeneous catalysts different? Give an example of each.

5. A certain first-order reaction has a half-life of 15 minutes.

   a) Calculate the rate constant for this reaction.
   b) How much time is required for this reaction to be 99% completed.

6. The following questions relate to figure 12.5 on page 541.

   a) Justify that this is a first order reaction.
   b) How much of this substance will remain after 800s.
   c) Determine the half-life for this reaction.
   d) If we double the concentration, what would the new half-life be.
7. The following questions relate to the chemical reaction and data below.

\[ A + 2B \rightarrow 2C + D \]

<table>
<thead>
<tr>
<th>trial</th>
<th>initial [A]</th>
<th>initial [B]</th>
<th>Rate (M/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>0.0400</td>
<td>0.0800</td>
<td>5.50 \times 10^{-2}</td>
</tr>
<tr>
<td>#2</td>
<td>0.0400</td>
<td>0.0400</td>
<td>2.75 \times 10^{-2}</td>
</tr>
<tr>
<td>#3</td>
<td>0.0800</td>
<td>0.0400</td>
<td>0.110</td>
</tr>
<tr>
<td>#4</td>
<td>0.0200</td>
<td>0.0200</td>
<td>?</td>
</tr>
</tbody>
</table>

a) Determine the rate law for this reaction.
b) Calculate the rate constant for this reaction.
c) Determine the rate for trial #4.
d) If trial was allowed to react to completion, what would the concentration of C and D be?
e) The student performing this experiment increases the temperature of trial 1 by 20°C. What would the new rate be?

8. For the following mechanisms, write the rate law and the overall net equation.

a. \[
\begin{align*}
H_3O^+ + I^- & \rightarrow H_2O + HI \\
(\text{fast}) \\
H_2O_2 + HI^- & \rightarrow H_2O + HOI \\
(\text{slow}) \\
H_3O^+ + I^- + HOI & \rightarrow 2H_2O + I_2 \\
(\text{fast}) \\
l_2 + I^- & \rightarrow l_3^- \\
(\text{fast})
\end{align*}
\]

b. \[
\begin{align*}
H_2O_2 + I^- & \rightarrow H_2O + OH^- \\
(\text{slow}) \\
H_3O^+ + I^- & \rightarrow H_2O + HI \\
(\text{fast}) \\
H_3O^+ + HI + OI^- & \rightarrow 2H_2O + I_2 \\
(\text{fast}) \\
l_2 + I^- & \rightarrow l_3^- \\
(\text{fast})
\end{align*}
\]

9. Why are catalysts more useful for increasing the reaction rate than raising the temperature?

10. How are adsorption and absorption different? How do they relate to catalysts?

11. Two molecules collide and they react to form a new compound. Two identical molecules collide and do not react. Explain why one of the pairs reacted and the other did not.

12. In general, how are zero, first and second rate laws different?

13. Give the half-life equations for zero, first and second order reaction.


a) Is the rate of reaction the same from 0 to 2000s? Explain.
b) Why does the rate change?
c) Write a rate law for the reaction.
d) Determine the rate constant for this reaction.