1. Which of the following expressions would be equal to the rate of the reaction below?

\[ 2 \text{KMnO}_4 + 3 \text{Na}_2\text{SO}_3 + \text{H}_2\text{O} \rightarrow 2 \text{MnO}_2 + 3 \text{Na}_2\text{SO}_4 + 2 \text{KOH} \]

1. \(-(\Delta[\text{KOH}] / 2 \cdot \Delta t)\)
2. \-(\Delta[\text{Na}_2\text{SO}_4] / \Delta t)\)
3. \((2 \cdot \Delta[\text{MnO}_2] / \Delta t)\)
4. \((\Delta[\text{H}_2\text{O}] / \Delta t)\)
5. \-(\Delta[\text{Na}_2\text{SO}_3] / 3 \cdot \Delta t)\)
6. \-(\Delta[\text{KMnO}_4] / \Delta t)\)

2. Consider the data below:

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.025</td>
<td>0.03</td>
<td>0.04</td>
<td>0.056</td>
<td>1.04 \times 10^{-6}</td>
</tr>
<tr>
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<td>0.12</td>
<td>0.04</td>
<td>0.056</td>
<td>4.16 \times 10^{-6}</td>
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<tr>
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<td>0.015</td>
<td>0.08</td>
<td>0.056</td>
<td>5.2 \times 10^{-7}</td>
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<tr>
<td>4</td>
<td>0.075</td>
<td>0.03</td>
<td>0.01</td>
<td>0.056</td>
<td>9.36 \times 10^{-6}</td>
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<tr>
<td>5</td>
<td>0.025</td>
<td>0.06</td>
<td>0.07</td>
<td>0.112</td>
<td>1.04 \times 10^{-6}</td>
</tr>
</tbody>
</table>

What is the overall order of this reaction?

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6

3. What would be the units of the rate constant (k) for the rate law below?

\[ \text{rate} = k \cdot [\text{O}_2] \cdot [\text{CO}]^{-1} \cdot [\text{Cl}_2]^1 \]

1. s\(^{-1}\)
2. M\(^{-2}\)·s\(^{-1}\)
3. M\(^{-1}\)·s\(^{-1}\)
4. M\(^1\)·s\(^{-1}\)

4. Consider two hypothetical zero-order reactions. If reaction 1 is faster than reaction 2 at room temperature, but slower than reaction 2 at much higher temperatures, then reaction 1 must have the (larger/smaller) activation energy and must have the (larger/smaller) pre-exponential factor. (Hint: consider both the Arrhenius equation and combined Arrhenius equation.)

1. larger, smaller
2. larger, larger
3. smaller, smaller
4. smaller, larger

5. Consider the elementary reaction:

\[ \text{H}_2\text{CO}_3(aq) \rightarrow \text{CO}_2(aq) + \text{H}_2\text{O}(l) \]

If \( k = 3.6 \times 10^2 \) s\(^{-1}\), and there is initially 0.781 M H\(_2\)CO\(_3\), what is the [H\(_2\)CO\(_3\)] after 1.2 ms have passed?

1. 0.507 M
2. 0.349 M
3. 0.584 M
4. 1.203 M

6. Consider the reaction:

\[ \text{AgClO}(aq) \rightarrow 1/2 \text{O}_2(g) + \text{AgCl}(s) \]

If \( k = 3.6 \times 10^2 \) s\(^{-1}\), and there is initially 0.781 M H\(_2\)CO\(_3\), what is the [H\(_2\)CO\(_3\)] after 1.2 ms have passed?

1. 0.507 M
2. 0.349 M
3. 0.584 M
4. 1.203 M
If an aqueous system initially has a [AgClO] of 112 mM and 3 minutes later has a [AgClO] of 7 mM, what is the half life of H₂O₂(aq)?

1. 90 seconds
2. 180 seconds
3. 60 seconds
4. 45 seconds
5. not enough information

7. To which of the following reactions would collision state theory not apply? (Note: consider the direction of the arrow in arriving at the correct answer).

1. N₂(g) + 3 H₂(g) → 2 NH₃(g)
2. CH₄(g) + 2 O₂(g) → CO₂(g) + 2 H₂O(g)
3. 2 H₂(g) + O₂(g) → 2 H₂O(g)
4. CaCO₃(s) → CaO(s) + CO₂(g)

8. Consider the reaction mechanism below:

step 1: 2 NO₂(g) → 2 NO(g) + O₂(g)
step 2: Br₂(g) + NO(g) → Br₂NO(g)
step 3: Br₂NO(g) + NO(g) → 2 BrNO(g)
overall: Br₂(g) + 2 NO₂(g) → 2 BrNO(g) + O₂(g)

If step 3 is the slow step, addition of which of the species below would slow down the observed rate of the reaction?

1. NO(g)
2. BrNO(g)
3. Br₂(g)
4. O₂(g)
5. Br₂NO(g)