Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **AP Kinetics Experiment**

Guiding Question: What is the rate law and rate constant of the iodine clock reaction?

Background Information: The reaction we will be studying is known as a “clock” reaction because it can be used to study reaction rates. Iodide ions will be oxidized by bromate ions in the presence of acid:

 6I- + BrO3- + 6H+ 🡪 3I2(aq) + Br- + 3H2O(l)

In order to calculate the rate of reaction, we must calculate the rate at which a reactant disappears or a product appears. This is most easily done by studying the rate at which the iodide ion is formed when the thiosulfate ion is added:

 3I2(aq) + 6S2O3-2 🡪 6I- + 3S4O6-2

This step is the slowest step (rate determining step). It is done first, and then the iodide ions produced immediately and quickly react with the bromate ions in the first equation. When starch is added in the reaction, the iodide ions create a blue complex which indicates the slow step is finished.

Pre-Lab Questions:

1. What factors must be held constant to ensure that only changes in concentration are affecting the rate of reaction?
2. Combine the equations in the introduction to create one overall reaction.
3. Write the rate expression for the bromate ions in the overall reaction.
4. Write a skeletal rate law (without order) for the first reaction (actually determined by the rate determining step).

Materials: 0.0100M KI, 0.00001M Na2S2O3, 0.0400MKBrO3, 0.100M HCl, 0.100M Cu(NO3)2, 2.00% starch solution, beakers, dropper, balance spot plate, toothpicks , stopwatch.

Procedure Part 1:

1. To find the mass of 1 drop tare an empty beaker.
2. Add 5 drops of water to the beaker and mass.
3. Add an additional 5 drops of water and mass.
4. Add an additional 5 drops of water and mass.
5. Complete table 1 below.

 **Table 1**

| Mass of first 5 drops of water |  |
| --- | --- |
| Mass of second 5 drops of water |  |
| Mass of third 5 drops of water  |  |
| Average mass of 5 drops of water |  |
| **Average mass of one drop of water** |  |

Procedure Part 2:

1. Using the quantities in table 2, add solutions in the order listed in that table, into the same well in the spot plate. Be careful to measure the exact drops. Stir solutions with a toothpick. (Water is only added to keep the total solution volume constant and starch is only used to determine the reaction rate).
2. As soon as you add KBrO3, time how long it takes the solution to turn even the slightest tint of blue. Record.
3. Repeat each experiment three times for accurate results. If one time goes wrong, eliminate it. Then find the average time elapsed for the trial.
4. Finally, repeat experiment 1 but add Cu(NO3)2 and only 3 drops of water before the KBrO3. Record the time.

 **Table 2**

| Trial | KI | H2O | HCl | Starch | Na2S2O3 | KBrO3 | Trial time (s) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | Average |
| 1 | 2 | 4 | 2 | 1 | 1 | 2 |  |  |  |  |
| 2 | 4 | 2 | 2 | 1 | 1 | 2 |  |  |  |  |
| 3 | 6 | 0 | 2 | 1 | 1 | 2 |  |  |  |  |
| 4 | 2 | 2 | 2 | 1 | 1 | 4 |  |  |  |  |
| 5 | 2 | 0 | 2 | 1 | 1 | 6 |  |  |  |  |
| 6 | 2 | 2 | 4 | 1 | 1 | 2 |  |  |  |  |
| 7 | 2 | 0 | 6 | 1 | 1 | 2 |  |  |  |  |
| 8 | 3 | 1 | 3 | 1 | 1 | 3 |  |  |  |  |

 **Trial 9 with catalyst: \_\_\_\_\_\_\_\_\_\_**

Questions:

1. Explain what trials 1-3 are testing.
2. Explain what trials 1, 4, and 5 are testing.
3. Explain what trials 1, 6, and 7 are testing.
4. Using the rate expression for the bromate ion, we will calculate the rate of each experiment:
	1. In each reaction one drop of 0.00100M sodium thiosulfate is used. Calculate the moles of sodium thiosulfate used in each experiment (all the same).
	2. Using the overall reaction, calculate the moles of bromate ions reacted.
	3. Every trial had a total of 12 drops. Calculate the concentration of bromate ions.
	4. The rate of reaction can be found by dividing your concentration of bromate ions by the average time elapsed for each trial. Calculate and complete table 3 column labeled “Rxn Rate (M/s).”

 **Table 3**

| Trial | Rxn Rate (M/s) | [Initial] (M) |
| --- | --- | --- |
| I- | BrO3- | H+ |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |
| 7 |  |  |  |  |
| 8 |  |  |  |  |

1. Calculate the concentrations of the ions using M1V1=M2V2 where M1 are found in the material sections, V1 is the number of drops of solute used, V2 is 12 (total drops) and M2 is x. Record answers in data table 3. Show one sample calculation.
2. Calculate the order of each reactant using the last four columns of your data table. Write the rate law.







1. Find the rate constant, k, for 2 experiments. Show your work and discuss the relationship between the two answers. Check units and sig-figs.







1. Experiment 8 is a check on your data. Plug the concentrations and rate constant in and solve for reaction rate. Is the experimental rate similar to your calculated rate?





1. What is the role of a catalyst? Explain how Cu(NO3)2 affected the rate of your reaction.