**Rates of Reaction: Iodination of Acetone**

**Introduction**:

The rate at which a chemical reaction occurs depends on several factors: the nature of the reaction, the concentrations of the reactants, the temperature, and the presence of possible catalysts. In this experiment you will study the kinetics of the reaction between iodine and acetone in acid solution:

O O

CH3 – C – CH3  + I2 + H+ → CH3 – C – CH2I + 2H+ + I-

For this reaction, you will determine the orders of the reaction with respect to acetone and HCl and find a value for the rate constant, k. Since the concentrations of acetone and HCl are much higher than that of I2, the concentrations of acetone and HCl will change very little. Thus the rate will be determined by the time needed for iodine to be used up. Iodine has color so you can easily follow changes in iodine concentration visually. The equation, Rate = k(A)m(H+)n(I2)p, can be simplified to Rate = [I2]/avg time since the values for acetone and HCl essentially remain constant during the course of any run.

**Purpose**:

The purpose of this reaction is to determine the orders for the reactants, the rate expression, and the rate constant for the reaction between iodine and acetone.

**Equipment/Materials**:

4.0 M acetone solution 125 mL Erlenmeyer flasks

1.0 M HCl solution 10 mL graduated cylinders

0.0050 M iodine solution watch or other timing device

100 mL beakers

**Safety**:

* Always wear goggles in the lab
* Acetone is flammable. There should be no open flames in the room.

**Procedure**:

1. For Trial 1, pipet the appropriate amount of actone, HCl, and water into the 100ml beaker; the iodine must be added last. (Be sure to clean the graduated cylinder after each solution)
2. Pour the solution from the beaker into the 125ml flask.
3. Simultaneously add the iodine to the flask and start the two stopwatchs; swirl the flask at a consistent rate. Stop the stopwatch when the color disappears and record the time for Run 1.
4. Rinse and dry the flask. Repeat the procedure for the remaining Trials and Runs.
5. Use the empty cleaned beaker to prepare the solution for the next trial. Also set up the iodine in the graduated cylinder.
6. For Trial 5, choose volumes for each liquid; the total volume must remain constant. If desired, choose volumes that should yield a short reaction time. Collect data for Trial 5.

**Data and Calculations:**

# Reaction Rate Data

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Trial | Volume  Acetone | Volume  HCl | Volume  Iodine | Volume  H2O | Total Volume | Time  1st Run | Time  2nd Run | Average  Time |
| 1 | 5 mL | 5 mL | 5 mL | 10 mL |  |  |  |  |
| 2 | 10 mL | 5 mL | 5 mL | 5 mL |  |  |  |  |
| 3 | 5 mL | 10 mL | 5 mL | 5 mL |  |  |  |  |
| 4 | 5 mL | 5 mL | 10 mL | 5 mL |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |

# Determination of Orders

Rate = k[acetone]m[I2]n[H+]p

[M] = moles/Liters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trial | [acetone][M] | [H+][M] | [I2] [M] | Rate =  [I2]/ave. Time |
| 1 | 0.80 | 0.20 | 0.0010 |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |

Order of Acetone “m” \_\_\_\_\_\_\_\_\_\_\_

Order of Iodine “n” \_\_\_\_\_\_\_\_\_\_

Order of Hydrogen Ion “p” \_\_\_\_\_\_\_\_\_\_\_

The Rate Law for the reaction before the calculation of k is: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is the overall order of the reaction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Determination of the Rate Constant k

Trial 1

Trial 2

Trial 3

Trial 4

Average Value for k \_\_\_\_\_\_\_\_\_\_

# Prediction of Reaction Rate

Use the data from Trial 5 to compare actual and predicted rates of reaction.

Rate = k[acetone]m[I2]n[H+]p

[acetone] = \_\_\_\_\_\_\_\_\_\_ [I2] = \_\_\_\_\_\_\_\_\_

[H+] = \_\_\_\_\_\_\_\_\_ k(average) = \_\_\_\_\_\_\_\_\_

Predicted Rate = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Experimental Rate = [I2]/Avg t = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Questions:**

1. Why is the concentration of iodine so much lower than the other reactants?

2. How are time and rate related? How are 1/time and rate related?

1. What does it mean when someone says a reaction is “first order”?

4. In a reaction, A + B → C, it is found that the reaction is first order in terms of A and B. What happens to the rate if the concentrations of A and B are doubled?