Chemical kinetics, a clock reaction

Science, Chemistry

Chemical Kinetics, A Clock Reaction Abstract The purpose for the experiment Chemical Kinetics, a clock reaction is to figure out the reaction rate of a solution regarding its concentration, temperature, and also determine the effects of when a catalyst is present. The experiment resulted that the concentration, as well as its temperature can affect the rate constant inversely the outcome of the rate constant. By conducting the experiment, it is also discovered that the rate order of the reaction resulted as [I-]= 1, [BrO3]= 1 [H+]= 2, the rate constant was averaged out at 33. 08 (1/M3s1) and the Activation Energy calculated to be 46 kJ. Introduction The significance of this experiment is to conduct trials of reactions under different circumstances to determine the dependence of each rate. The reaction rate is an expression of the speed of each reaction in respect of the concentration of each solution and the temperature at which the reaction takes place. The experiment focuses primarily on the reaction between the ions bromate and iodide. 6I-(aq) + BrO3-(aq) + 6H+ 3I2(aq) + Br-(aq) + 3H2O(l) (1) In part one to determine the rate order of the ions the rate law of reaction is used as well as to find the rate constant (k). Rate Law of Reaction Rate= k[I-]x[BrO3-]y[H+]z (2) For part three, the Arrhenius equation is used to calculate the activation energy (Ea) Arrhenius Equation (3) The Ea can be easily found by plotting data into excel and thus giving the slope (Ea) Experimental The experiment is done three parts parts. In part one, the goal is to find the dependence of the reaction rate of concentration. The first part of the experiment relates a table (Table 1) that indicates 3 reagents (KI, Na2S2O3, and H2O), all with the measurement of 10mL each, be poured into flask one and 2 other reagents (KBrO3 and HCl), both with the measurement of 10mL each, a long with starch in flask two. (Table 1) indicates the different volumes of reagents that would be poured in the flasks. The reagents in flask two were mixed into the components of flask one. The solution was swirled while being recorded by a stopwatch and a thermometer. When the solution turned blue, time was recorded as well as the temperature. The procedure was repeated four more times with different volumes in respect to Table 1. Table 1 In part two, the dependence of reaction rate on temperature is determined. This time only reaction mixture one is used. Mixture one is done under the temperatures 40C, 10C and 0C. A water bath was heated to 40C and just like in part 1, KI, Na2S2O3, and H2O were in flask one and KBrO3 and HCl were in flask two along with 3 drops of starch. Reaction flask two was added to flask one, put in the water bath and swirled until the solution turned blue. The time and temperature were also recorded. For 10C and 0C, the water bath was cooled to the necessary temperature with ice. The experiment was repeated as before. For part three, a catalyst was added to the solution for the purpose of observing the difference in reaction rate of the solution. Repeating the procedure of part 1, the addition of a catalyst ((NH4)MoO4) is made to flask two. It was observed that adding one drop of 0. 5M((NH4)MoO4) to the solution sped up the reaction rate. Results and Discussion In table 2 Part 1, (Dependence of Reaction Rate on Concentration) it is analyzed that the concentration has a direct relationship to the reaction rate. In trial two, the concentration of [I-] is doubled than the concentration in trail one. By analyzing the data, it is determined that the higher the concentration of the reagent, the faster the reaction rate. Summing up all the data from Table 2, it is established that the rate order can be found from equation (blah). The reaction order is represented as x= 1, y= 1, and z= 2. Table 2 Mix | Time (s) | Rate -âˆ†[BrO3-]/âˆ†t= 3. 33 x 10-5 (mol/L)/âˆ†t | Reactant Concentration (mol/L)[I-] | [BrO3] | [H+] | Temp (C) | 1 | 135 | 2. 46 x 10-7 | 0. 0020 | 0. 008 | 0. 02 | 22. 1 | 2 | 74 | 4. 50 x 10-7 | 0. 0040 | 0. 008 | 0. 02 | 21. 5 | 3 | 87 | 3. 82 x 10-7 | 0. 0020 | 0. 016 | 0. 02 | 21. 3 | 4 | 45 | 7. 4 x 10-7 | 0. 0020 | 0. 008 | 0. 04 | 21. 3 | 5 | 195 | 1. 70 x 10-7 | 0. 0016 | 0. 004 | 0. 03 | 22. 1 | Table 3 Determining k To calculate k, equation (2) is used. By taking the molarities of trails one through four, as well as the reaction rates, they are placed into the equation. After getting four k's, they are averaged out resulting in 33. 08(1/M3s) Reaction | 1 | 2 | 3 | 4 | k= | 38. 43 | 35. 15 | 29. 84 | 28. 91 | Kaverage = 33. 08 Table 4 Part 2 (Dependence of Reaction Rate on Temperature) Mixture | Time (s) | Rate =-âˆ†[BrO3]/âˆ†t (mol/L-s) | Temp (C) | Calculated k (M-3s-1) | 1A | 30s | 1. 11 x 10-6 | 46. 2 | 173 | 1B | 135s | 2. 46 x 10-7 | 22. 1 | 38. 33 | 1C | 429s | 7. 76 x 10-8 | 10 | 12. 91 | 1D | 528s | 6. 30 x 10-8 | 22 | 9. 84 | The data given, shows that temperature has a direct effect with the rate reaction. In trial 1A, the reaction had a temperature of 40C which was higher than trial 1B at 20C. The results of trial 1A showed that the reaction rate was higher than that of trial 1B. Graph 1 (ln k vs 1/T) In the graph ln k vs 1/T the data plotted is a linear graph. It is analyzed that the inverse of k has a direct relationship with the inverse of temperature (kelvin). The graph also shows that as the temperature increases, the rate constant decreases. The Activation Energy was calculated by using equation (3). The results concluded that the Activation Energy was 46 kJ Part 3 of the experiment determines what the presence of the catalyst does to the reaction. In reaction mixture one (Table

2), it took the reaction 135 seconds for the solution to turn blue without a catalyst. With the addition of the catalyst, the reaction took 14 seconds to react. The results show that the catalysts purpose is to speed up the reaction, but lower the activation energy. Conclusion Thus, the experiment shows that there are different factors that should be taken into consideration when determining the rate reaction, the rate order, k, and EA. Those include the temperature and the concentration. The results show that the higher the temperature, the higher the k and that the higher the concentration, the faster the reaction rate. Also, even though the catalyst increased the rate of the reaction, it did not slow down the EA. The k (33. 08 M-3s-1), was calculated by using formula (2) and the EA (46 kJ) using formula (3).