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CHMG 146 Section 12

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# *Lab 1: Kinetics*

***Abstract***

In this experiment, the kinetics theory was applied in a real-world example to determine the frequency factor of various amounts of Potassium Permanganate and Oxycilic Acid solutions. This value was found throughout two experiments. The first of which was to find the rate at which the Potassium Permanganate was consumed. The second of which was to use that rate to determine the frequency factor. After such procedures, the frequency factor was determined for differing temperatures then averaged to 78,880,000 $M^{-1}s^{-1}$.

***Experimental***

For this experiment, the concepts of kinetics theory were applied in a real-world example. First, the lab's temperature was recorded, and the concentrations of the Potassium Permanganate and Oxycilic acid were found using Equation 1.

*Equation 1:*

$$M_1 * V_1 = M_2 * V_2$$

Distilled water and Oxylicic acid were added to a test tube, and Potassium Permanganate was added to another. These values are in Table 1.

*Table 1:*

| | ***Experiment 1*** | ***Experiment 2*** | ***Experiment 3*** |
|---|---|---|---|
| ***Distilled $H_2O$*** | 6 mL | 1 mL | 5 mL |
| ***0.130 M $KMnO_4$*** | 1 mL | 1 mL | 2 mL |
| ***0.755 M $H_2C_2O_4$*** | 5 mL | 10 mL | 5 mL |
| ***Total*** | 12 mL | 12 mL | 12 mL |

For each experiment, the Potassium Permanganate was added to the beaker filled with the distilled water and Oxycilic acid. The beakers were stirred, and the time was recorded until the solution became a pale yellow. The times were recorded in *Results Table 1*. Each solution's concentration was calculated using *Equation 3* and used to determine rate *k* in *Equation 4*.

*Equation 3:*

$$\frac{mL\ of\ solute * Molarity}{total\ mL\ of\ solution} = Molarity$$

*Equation 4:*

$$rate = k\,[KMnO_4]^X\,[H_2C_2O_4]^Y$$

Next, the X, Y, and k values were solved via logarithms and each solute's molarity. The next experiment required to follow the same experiment except the mixing occurred in a water bath of varying temperatures in *Results Table 2*. Using these temperatures and times, the rate was determined by dividing the molarity of Potassium Permanganate divided by the time it took for the solution to reach a pale yellow-orange color. This value is then divided by the molarity of both solutes. The natural log of this newly calculated value is then placed on the y-axis while the reciprocal of the kelvin temperature is placed on the x-axis, as seen in *Results Graph 1*.

***Results and Discussion***

*Table 1: Times and average for each experiment until the solution became pale yellow-orange*

| | ***Experiment 1*** | ***Experiment 2*** | ***Experiment 3*** |
|---|---|---|---|
| | 377 s | 160 s | 197 s |
| | 365 s | 157 s | 200 s |
| | 326 s | 148 s | 208 s |
| ***Average Time*** | 356 s | 153 s | 201.67 s |

*Solved values:*

X = 1

Y = 1.222

k = 0.011

Ea = 55,665.5556 Joules *From Equation 5*

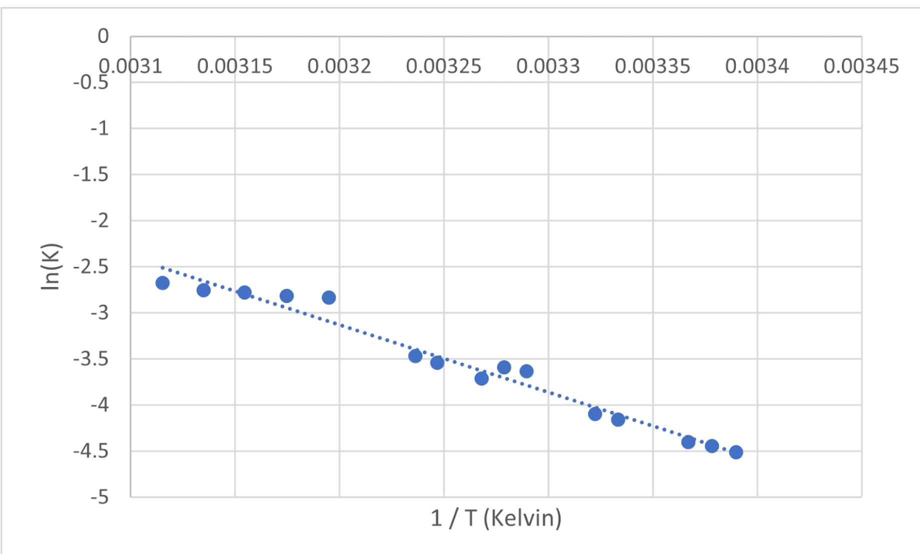
A = 78,880,000 $M^{-1}s^{-1}$ *From Results Graph 2*

*Table 2: Temperatures of water bath and time until the solution became pale yellow-orange*

| ***Ex 1 Temp*** | ***Ex 1 Time*** | ***Ex 2 Temp*** | ***Ex 2 Time*** | ***Ex 3 Temp*** | ***Ex 3 Time*** |
|---|---|---|---|---|---|
| 48 ºC | 46 s | 31 ºC | 120 s | 28 ºC | 191 s |
| 40 ºC | 54 s | 36 ºC | 102 s | 27 ºC | 203 s |
| 46 ºC | 50 s | 35 ºC | 110 s | 24 ºC | 260 s |
| 44 ºC | 51 s | 33 ºC | 130 s | 23 ºC | 271 s |
| 42 ºC | 53 s | 32 ºC | 115 s | 22 ºC | 290 s |

Results from Microsoft Excel gave the line of best fit the equation y = -6695.4x + 18.2. This leads the Activation energy to be 55,665.5556 Joules via *Equation 5*. This then means that the Frequency Factor can be determined via *Equation 6* for each different rate constant. Once averaged, this value is 78,880,851.25 $M^{-1}s^{-1}$. Once rounded to significant figures, this value is 78,880,000 $M^{-1}s^{-1}$.

*Graph 1: Relationship between the natural log of the constant, k, and the reciprocal of the temperature in Kelvin*




*Equation 5:*

$$ln(k) = ln(A) - \frac{Ea}{RT}$$

*Equation 6:*

$$k = A\, e^{-Ea\,/\,RT} == A = k\, /\, e^{-Ea\,/\,RT}$$

*Graph 2: Relationship between the temperature in Kelvin and Frequency Factor*