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PLEASE NOTE: If ANY of the above information is UNCLEAR or not provided, your grade will NOT be recorded!!

Lab Day (circle):	*Tues*	*Wed*	*Thurs*	*Fri*
Time slot (circle):		*morning*	*afternoon*	*night*
Lab Week (circle):		*1*	*2*	

Laboratory Report Cover Page

Experiment 3.

Chemical Kinetics

Checklist:

- **Raw Data Sheet copy attached**
- **9 curves [3 for A vs t; 3 for log A vs t; 3 for log Rate vs log A] attached**
- **Completed formal report typed and attached**

Student's Initials: S.M.S

Introduction

It is essential that the mechanics of the chemical is reaction is understood. The rate of reaction, or in other words, the speed of the formation of the products, is a highly significant concept in chemistry. For instance, in a work space where multiple reactive substances are being used, it is crucial that one must make certain that all factors impacting the rate of reaction are in check. If not, catastrophic events will most likely occur. The change of a rate of reaction depends on the temperature, concentration, physical state and the use of a catalyst (if used). The temperature and concentration are directly related to the rate. The molecule's average energy increases as the value of the temperature increases. This increases rate because when molecules collide with other molecules they must be traveling at a certain speed in order for the reaction to take place. The frequency of collisions are increased when the concentration value increases. As the concentration greatens, the environment the substance is in gets filled with more molecules, thus, leaving the frequency of collisions increase. Catalysts speeds up reactions by lowering the activation energy (the least amount of energy required by a substance for a reaction to occur). Therefore, when a catalyst is used, the molecules do not have to exert as much energy because the catalyst accelerates the reaction process by reducing the activation energy. When reactants of a reaction are in the same state, the reaction occurs much faster oppose to when the reactants are in a different state. In this experiment, majority of the factors effecting rate is controlled. The only factor that comes in to play is the concentration of the substances.

The relationship between the concentrations of the reactants and the rate of the reaction is stated by the equation:

$$\textbf{Rate} = k[A]^n[B]^m$$

The **[A]** means the concentration of the reactant A. The **[B]** means the concentration of reactant B. The concentration of the reactants are measured in M (moles(liters^{-1})). The **k** variable represents the rate constant. The value of the rate constant is unique to all chemical reactions. The **exponents** (**m** and **n**) represent the order of reaction in respect to the concentration. They are identified as partial orders. The overall reaction order can be obtained by adding all the exponents and each exponent can tell the reader the effect of that single reactant.

Given Chromium (ii) Nitrate and Sodium EDTA, students must find the partial order of the reaction, with respect to the Cr(iii) ion. The rate expression for this reaction is:

$$\textbf{Rate} = k[Cr(iii)^a[H^+]^b$$

A spectrophotometer is used to determine the **[Cr(iii)][a]** values. It measures ratio of the intensity of the light after that light goes through a substance. This is called transmittance. The intensity of the light before it makes contact with the substance is represented by ***I*** and the intensity of the light after the light passes through a substance is I_o. The ratio of the intensity of light after the light goes through a substance is represented by T. The formula to illustrate is concept is:

$$\mathbf{T = I/I_o}$$

One can calculate the light absorbed ($\mathbf{A_t}$) by the substance by using the following formula:

$$\mathbf{A_t = -logT}$$

This formula is important because it calculates the quantity of light absorbed. At the end of the experiment, one will receive a value of the absorbance at an infinite time ($\mathbf{A_\infty}$**)** through the spectrophotometer, and with this information, one can figure out the absorbance of the Cr(iii) ions using the formula:

$$\mathbf{A_{Cr(III)} = A_\infty - A_t}$$

The $\mathbf{A_{Cr(III)}}$ value which represents the absorbance of the Cr(III) ions, will now be considered as the concentration of the Chromium ions. If one considers $[H^+]$ to be constant, the order of reaction can be obtained using the equation:

$$\log \boldsymbol{Rate} = \boldsymbol{a} \log[\boldsymbol{Cr}(\boldsymbol{III})] + \log \boldsymbol{k}$$

Procedure

Procedure: As described in the lab manual (What in the World ISN'T Chemistry – "If it were done… then 'twere well it were done quickly," Chemical Kinetics, Dr. Rashmi Venkateswaran, 2000, Exp. 2, p. 27).

Observations

*note: the constant volume used in the cuvette in each of these trials was 10ml

*Accurate data of volume of EDTA (ml), drops of Cr(III), temperature of the solution cannot be noted because the data used is Gabrielle Lazo's and Cynthia Chan's data.

pH 5.0:

	Run 1									
	Time (min)	Trans @ (%)	A(t)	A(t) 2	A Cr	A Cr(III)	Time (f)	log A Cr(III)	Rate	log Rate
6	10	78.719	0.10392	0.10392	1.377	1.36540	12	0.13526	0.00538	-2.269
7	12	76.718	0.11510	0.11510	1.365	1.35457	14	0.13180	0.00563	-2.249
8	14	74.829	0.12593	0.12593	1.355	1.34286	16	0.12803	0.00584	-2.234
9	16	72.838	0.13764	0.13764	1.343	1.33124	18	0.12425	0.00602	-2.220
10	18	70.915	0.14926	0.14926	1.331	1.31880	20	0.12018	0.00623	-2.205
11	20	68.912	0.16170	0.16170	1.319	1.30624	22	0.11602	0.00640	-2.194
12	22	66.948	0.17426	0.17426	1.306	1.29315	24	0.11165	0.00651	-2.186
13	24	64.961	0.18735	0.18735	1.293	1.28008	26	0.10724	0.00657	-2.183
14	26	63.035	0.20042	0.20042	1.280	1.26665	28	0.10266	0.00653	-2.185
15	28	61.116	0.21385	0.21385	1.267	1.25427	30	0.09839	0.00659	-2.181
16	30	59.397	0.22623	0.22623	1.254	1.24037	32	0.09355	0.00667	-2.176
17	32	57.527	0.24013	0.24013	1.240	1.22704	34	0.08886	0.00649	-2.188
18	34	55.788	0.25346	0.25346	1.227	1.21420	36	0.08429	0.00621	-2.207
19	36	54.163	0.26630	0.26630	1.214	1.20246	38	0.08007	0.00601	-2.221
20	38	52.718	0.27804	0.27804	1.202	1.19062	40	0.07577	0.00593	-2.227

pH 4.5:

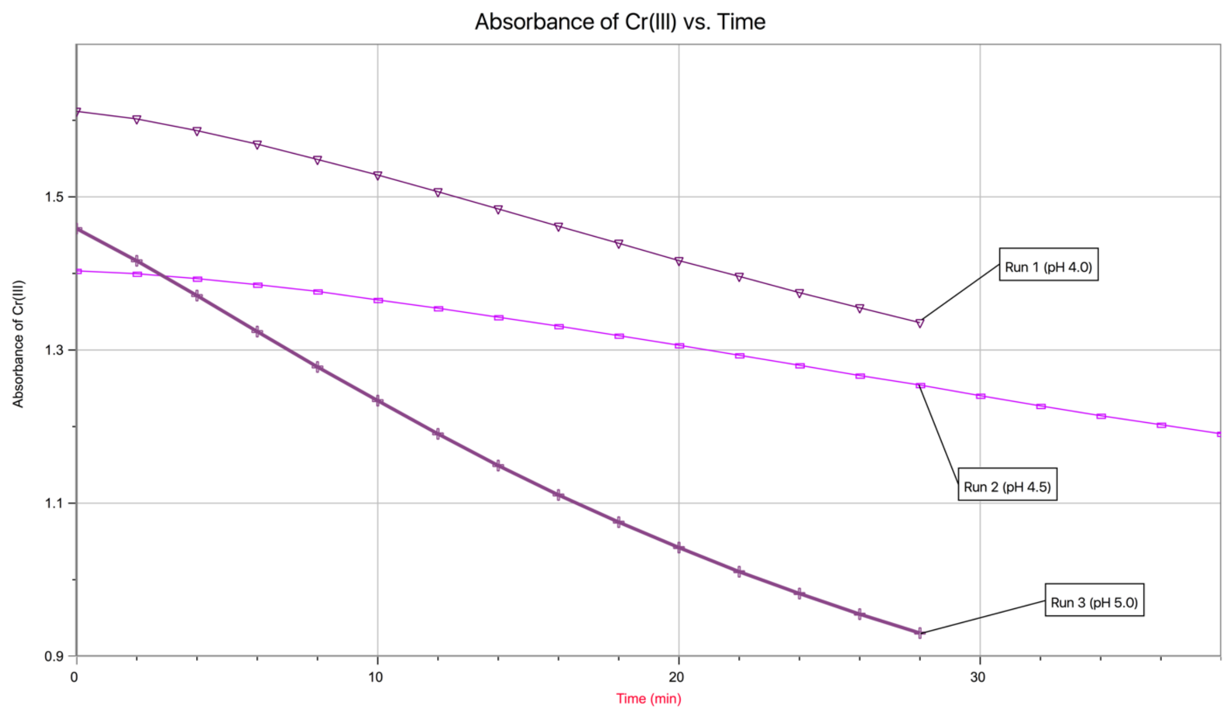
	Run 2									
	Time (min)	Trans @ (%)	A(t)	A(t) 2	A Cr	A Cr(III)	Time (f)	log A Cr(III)	Rate	log Rate
6	10	71.296	0.14693	0.14693	1.549	1.52857	12	0.18429	0.01053	-1.978
7	12	68.041	0.16723	0.16723	1.529	1.50672	14	0.17803	0.01097	-1.960
8	14	64.703	0.18908	0.18908	1.507	1.48429	16	0.17152	0.01118	-1.952
9	16	61.445	0.21151	0.21151	1.484	1.46168	18	0.16485	0.01119	-1.951
10	18	58.328	0.23412	0.23412	1.462	1.43945	20	0.15820	0.01112	-1.954
11	20	55.418	0.25635	0.25635	1.439	1.41676	22	0.15130	0.01082	-1.966
12	22	52.597	0.27904	0.27904	1.417	1.39618	24	0.14494	0.01049	-1.979
13	24	50.162	0.29962	0.29962	1.396	1.37492	26	0.13828	0.01023	-1.990
14	26	47.766	0.32088	0.32088	1.375	1.35518	28	0.13200	0.00995	-2.002
15	28	45.644	0.34062	0.34062	1.355	1.33573	30	0.12572	0.00981	-2.008
16	30	43.644	0.36007	0.36007	1.336					
17	32	2.015	1.6958	1.6958	0.000					
18										
19										
20										

pH 4.0:

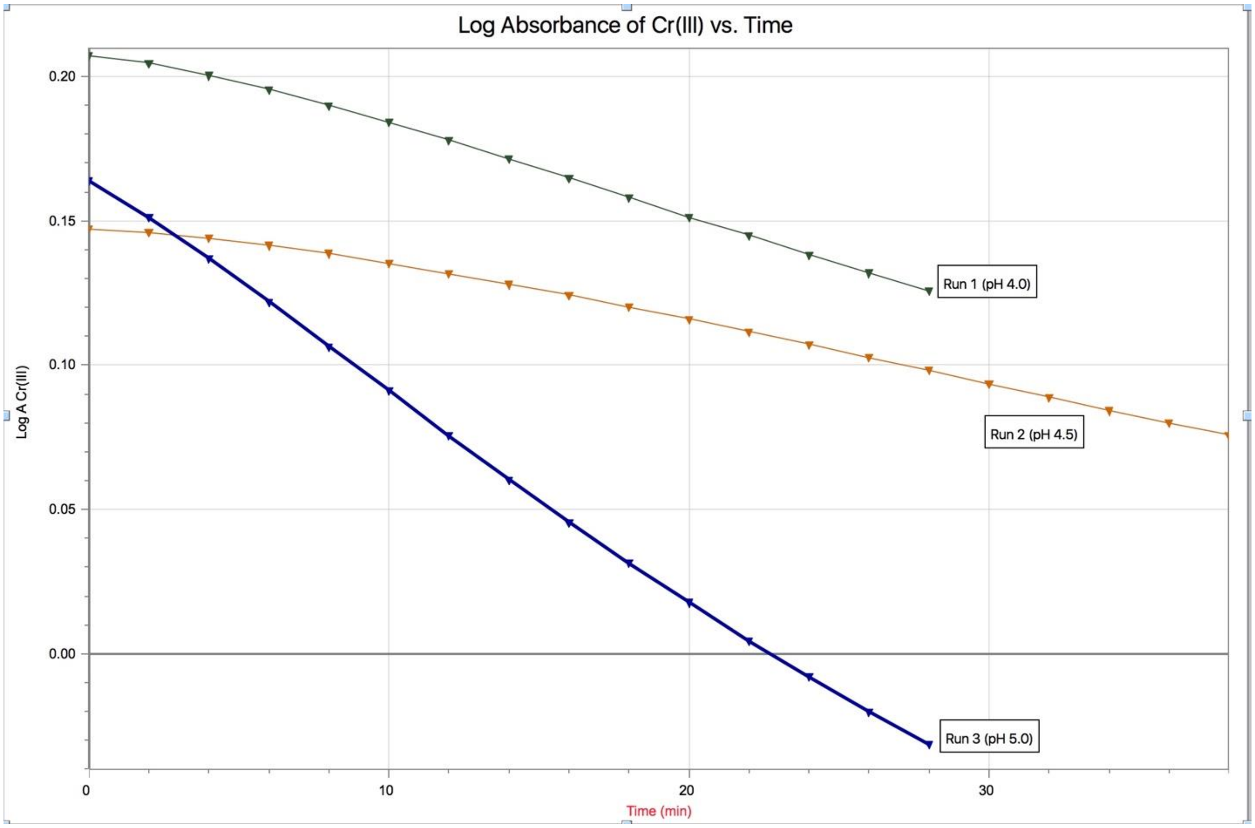
	Run 3									
	Time (min)	Trans @ (%)	A(t)	A(t) 2	A Cr	A Cr(III)	Time (f)	log A Cr(III)	Rate	log Rate
6	10	51.759	0.28602	0.28602	1.278	1.23390	12	0.09128	0.02183	-1.661
7	12	46.773	0.33000	0.33000	1.234	1.19048	14	0.07572	0.02102	-1.677
8	14	42.323	0.37342	0.37342	1.190	1.14909	16	0.06036	0.01986	-1.702
9	16	38.476	0.41481	0.41481	1.149	1.11069	18	0.04559	0.01853	-1.732
10	18	35.220	0.45321	0.45321	1.111	1.07522	20	0.03150	0.01726	-1.763
11	20	32.458	0.48868	0.48868	1.075	1.04198	22	0.01786	0.01615	-1.792
12	22	30.067	0.52192	0.52192	1.042	1.01046	24	0.00452	0.01502	-1.823
13	24	27.961	0.55344	0.55344	1.010	0.98194	26	-0.00792	0.01399	-1.854
14	26	26.184	0.58196	0.58196	0.982	0.95504	28	-0.01998	0.01323	-1.879
15	28	24.612	0.60886	0.60886	0.955	0.93034	30	-0.03136	0.01270	-1.896
16	30	23.251	0.63356	0.63356	0.930					
17	32	2.730	1.5639	1.5639	0.000					
18										
19										
20										

*note: data courtesy of Cynthia Chan and Gabriel Lazio

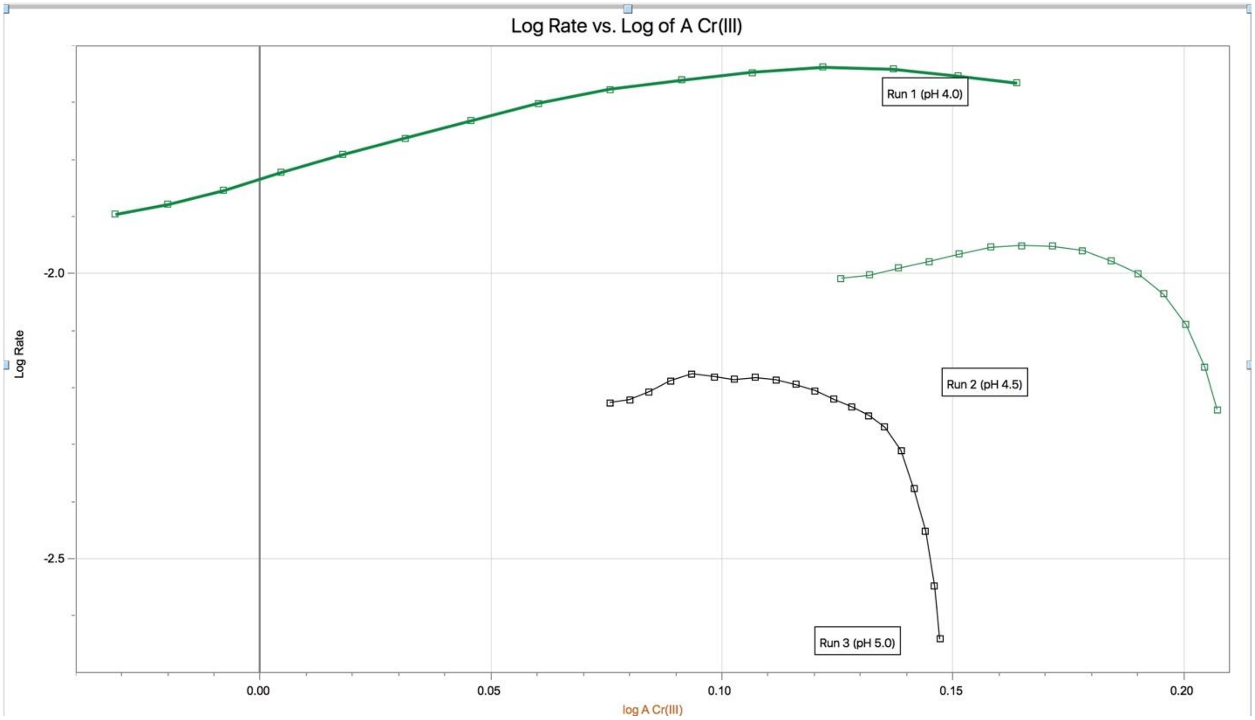
Graphs:



Absorbance of Cr(III) vs. Time
Absorbance of Cr(III)
Time (min)
1.5
1.3
1.1
0.9
0
10
20
30
Run 1 (pH 4.0)
Run 2 (pH 4.5)
Run 3 (pH 5.0)



Log Absorbance of Cr(III) vs. Time
0.20
0.15
0.10
0.05
0.00
Log A Cr(III)
0
10
20
30
Time (min)
Run 1 (pH 4.0)
Run 2 (pH 4.5)
Run 3 (pH 5.0)



When the chromium drops were added to the EDTA solution, the reaction occurred at a very slow process. Although, it is evident that a reaction was taking place because the colour of the solution gradually turned into a dark purple colour. Distilled water and acid solution had chromium drops added to it. But, the distilled water had a darker purple colour. After the cuvette was removed from each heated water bath, all solutions had a darker purple colour. It is also observed that the solutions with a higher pH recorded a greater %transmittance.

Calculations:

*All the calculations are done using logger pro

Discussion:

In this experiment, %transmittance was measured for three different pH levels. It is observed that there is a decrease in the transmittance percentage for all the pH levels as the time progressed. For pH 5.0, the transmittance percentage dropped from %78.719 to %68.912 as the time went from 10 to 20 minutes. The percent transmittance of pH 4.5 at 10 minutes is %71.296. The percent transmittance of pH 4.5 reduced to %55.418 at 20 minutes. Similar trends occurred in the pH 4.0 solution. The percentage transmittance dropped from %51.759 at 10 minutes to %32.458 at 20 minutes. All three experiments showed that for all pH solutions, as time progressed, the %transmittance decreased and the absorbance increased. However, the absorbance of Cr(III) decreased for each trial as time progressed. For pH 5.0, the absorbance of Cr(III) decreased from 1.36540 at 10 minutes to 1.30624 at 20 minutes. For pH 4.5, the absorbance of Cr(III) decreased from 1.52857 at 10 minutes to 1.41676 at 20 minutes. For pH 4.0, the absorbance of Cr(III) decreased from 1.23390 at 10 minutes to 1.04198 at 20 minutes.

Although, the data used in this report is collected by another group, there are few errors they could have made. For starters, the temperature of the water bath. The temperature is highly influential factor in an experiment based on chemical kinetics. The temperature of the water bath could have changed throughout the experiment. The way to avoid this problem is to allow the water temperature to reach a point of equilibrium before the experiment commenced. Another potential source of error, could be the time the cuvette was measured for the transmittance. It is possible that the other group left out the cuvette when being transported from the water to bath to the spectrometer for a long time. It is possible that the cuvette was also not properly cleaned when transitioning from trial to trial. There also could have been dirt on the side of the tube, which caused an inaccurate percent transmittance value. This is because the dirt could be blocking light, in result, lowering the value the spectrophotometer produces.

The volume and temperature are important. This is because an increase in volume and temperature can change the reading in spectrophotometer. As the volume increases the reaction decreases. As the temperature increases, the rate of reaction increases. But in this lab, the volume and temperature is controlled and is attempted to remain constant. If the temperature and the volume remains constant, the data is reproducible.

Conclusion

The results from the graphs read that pH 4.0 has a second order of reaction. While, pH 4.5 and 5.0 has a first order of reaction.

Sajana & Vibisan

S40-7.

Observations

pH 0.1M EDTA = 4.5 P
- ignore run 1 & 2
- within 30 seconds, colour changed to dark purple
- vile was too warm during first run
- vile was placed in cool water. to ~~create results~~ allow for results wanted to show on the screen.

4mins in hot beaker → Cr solution & pH edTA

Trial 2

pH 4.0 edTA 0.1M =
~~trial~~ trial 1 = did not heat and is ~~being~~ being recorded for ~~[illegible]~~ 34min

trial 2 = heated ~~[illegible]~~ to 40min   So 6 mins ~~[illegible]~~

- ~~time reduced to [illegible]~~

pH 4.5 = trial 1 = ~~[illegible]~~ 14 min recorded
trial 2 = 6 min reorded in total 20 min recorded

pH 5.0 = trial 1 = ~~X~~ EMONE.