Student Name:	Tyler Dennis
Student Number:	9008435
Partner’s Name and Student #:	John Smith 8263965
Demonstrator's Name:	Joe King

Lab Day:	Tuesday Night
Lab Week:	2

Laboratory Report Form
Experiment 4.
Chemical Kinetics

Student's Initials: TD

Introduction:

Chemical reaction are reactions between compounds that form new compounds or alter the properties of the existing ones. This particular lab is focussed on finding out how the pH of a substance affects the rate of the reaction, this is particularly known as the order of reaction. (Venkateswaran, 2013). The rate law is an expression indicating how the rate directly depends on the concentration of the reactants and the catalyst(s). The exponent in the rate law equation represents the order of the reaction (Univeristy of Waterloo, n.d.). The rate law equation is: Rate $= k(A)^m(B)^n$.

Spectrophotometry is the study of matter through observing the interaction of electromagnetic radiation. To capture the data collected in the lab, a spectrophotometer is used to calculate the transmittance and the absorbance.

The ultimate goal of this lab is to find the amount of unreacted Cr(III). This amount can be found by using the percent transmittance of light through the substance. By taking the negative logarithm of the percent transmittance, this value gives the percent absorbance. By using the percent absorbance at completion subtracting the absorbance at any time (t), this value gives the amount of Cr(III) remaining.

References:

Chung C. (2013) Rates and Order of Reactions. University of Waterloo: Retrieved from: http://www.science.uwaterloo.ca/~cchieh/cact/c123/rate.html

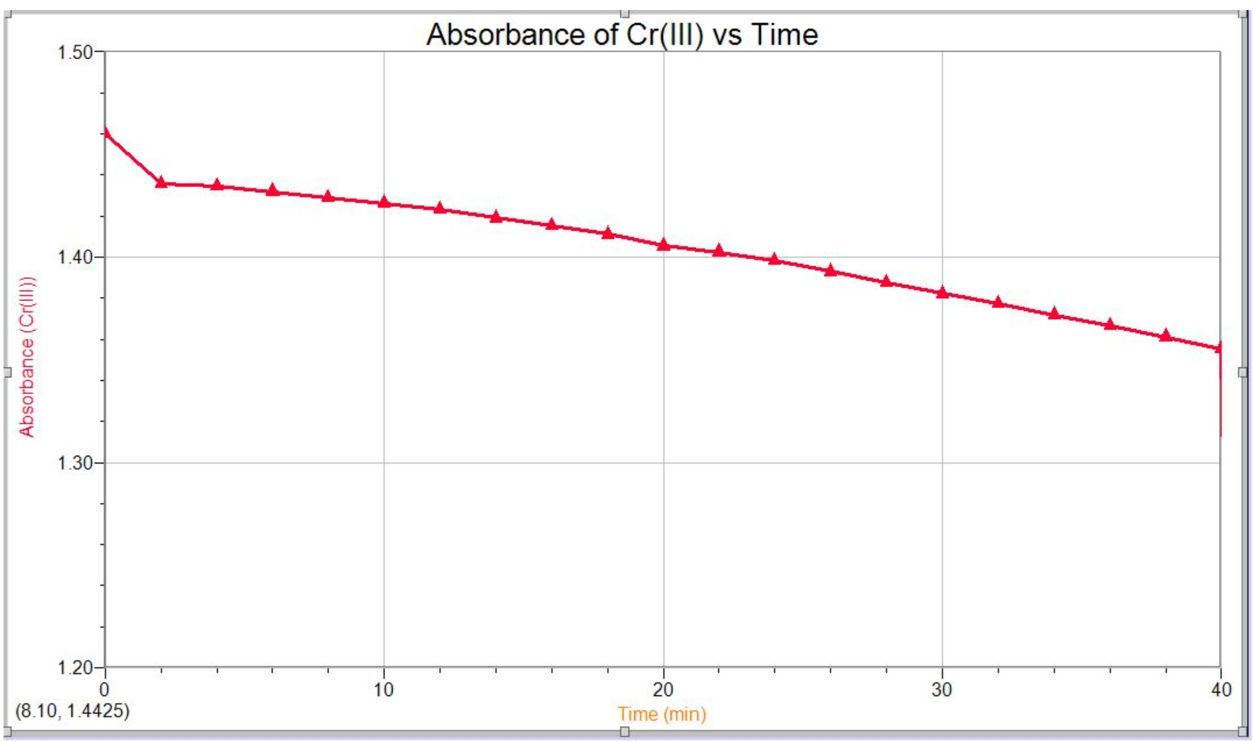
Procedure:

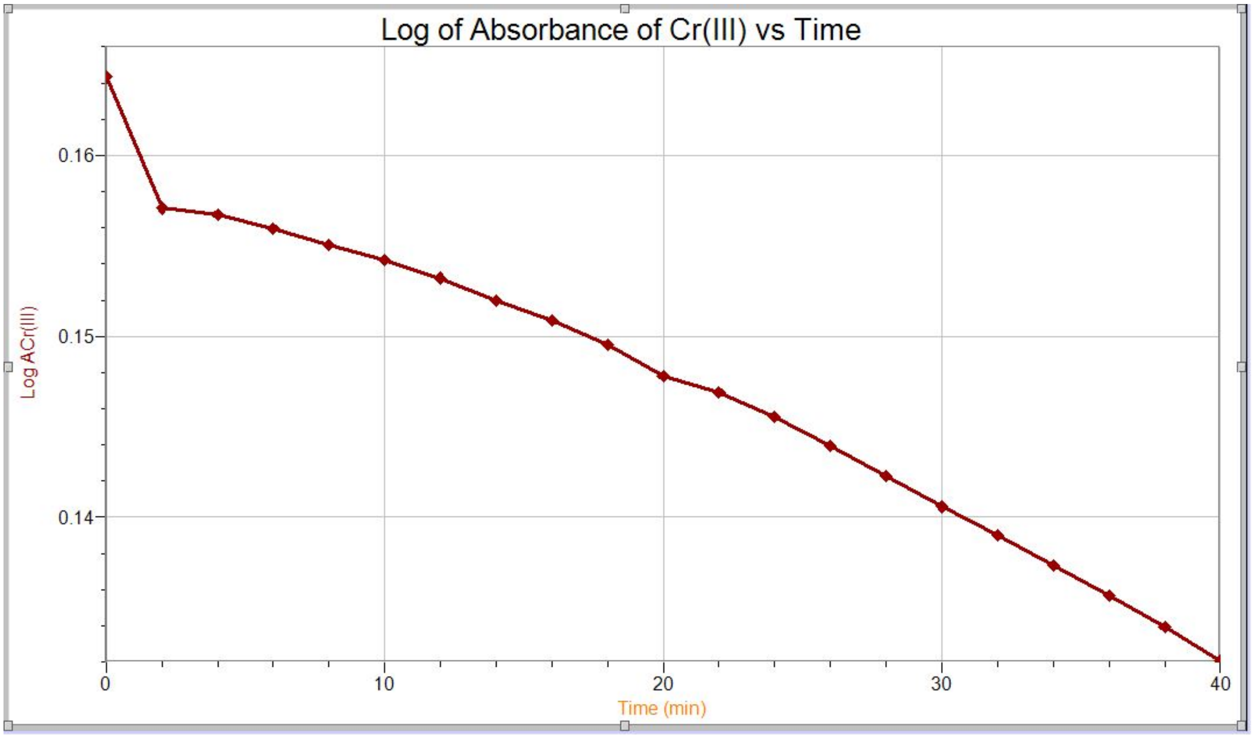
As described in the lab manual

Data and Observation Results:

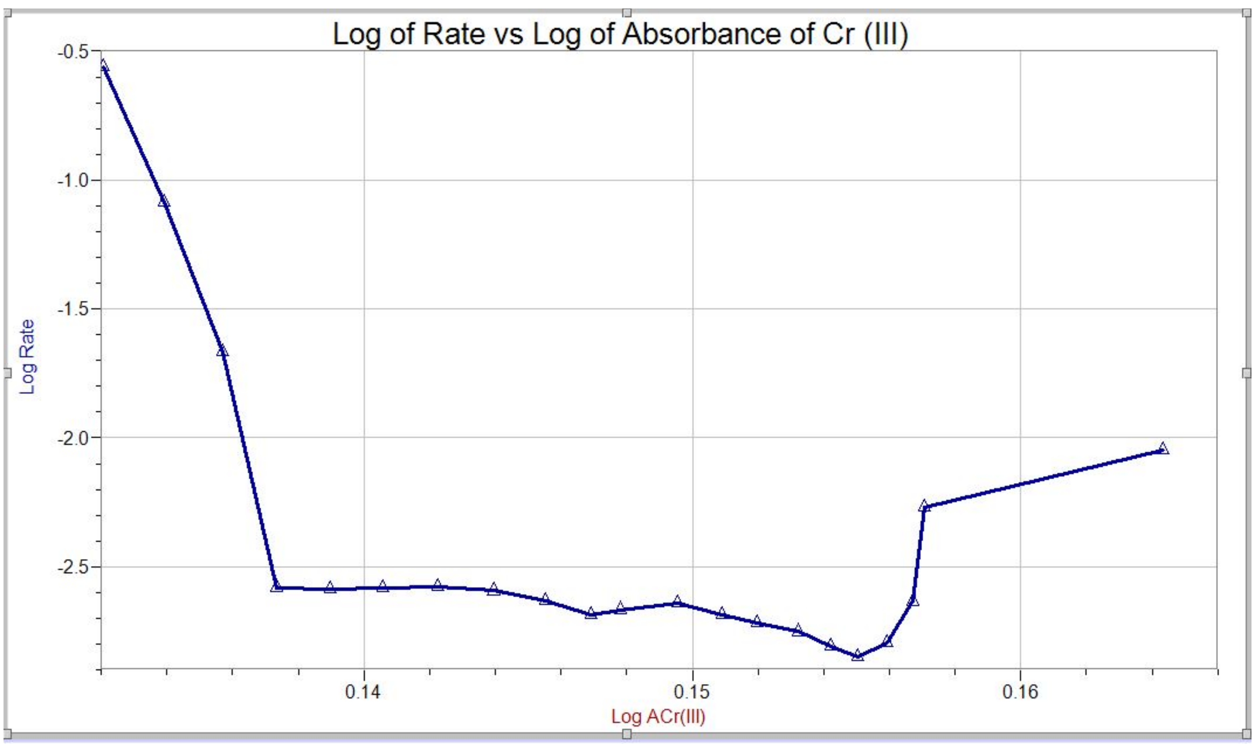
At pH of 4.0

	Run 2						
	Time (min)	Trans @ 576.5 nm (%)	Ab	ACr(III)	LogACr(III)	Rate	Log Rate
1	0	85.494	0.068	1.460	0.164	0.00894	-2.049
2	2	80.865	0.092	1.436	0.157	0.00537	-2.270
3	4	80.638	0.093	1.435	0.157	0.00232	-2.634
4	6	80.162	0.096	1.432	0.156	0.00160	-2.797
5	8	79.618	0.099	1.429	0.155	0.00142	-2.849
6	10	79.129	0.102	1.426	0.154	0.00155	-2.809
7	12	78.530	0.105	1.423	0.153	0.00177	-2.752
8	14	77.804	0.109	1.419	0.152	0.00191	-2.719
9	16	77.175	0.113	1.415	0.151	0.00205	-2.687
10	18	76.399	0.117	1.411	0.150	0.00229	-2.640
11	20	75.409	0.123	1.405	0.148	0.00215	-2.667
12	22	74.909	0.125	1.403	0.147	0.00206	-2.687
13	24	74.148	0.130	1.398	0.146	0.00234	-2.631
14	26	73.280	0.135	1.393	0.144	0.00255	-2.593
15	28	72.376	0.140	1.388	0.142	0.00264	-2.578
16	30	71.488	0.146	1.382	0.141	0.00262	-2.582
17	32	70.656	0.151	1.377	0.139	0.00260	-2.585
18	34	69.812	0.156	1.372	0.137	0.00263	-2.580
19	36	68.982	0.161	1.367	0.136	0.0215	-1.668
20	38	68.103	0.167	1.361	0.134	0.0816	-1.089
21	40	67.196	0.173	1.355	0.132	0.275	-0.561
22	42	2.963	1.528	0.000		0.490	-0.309





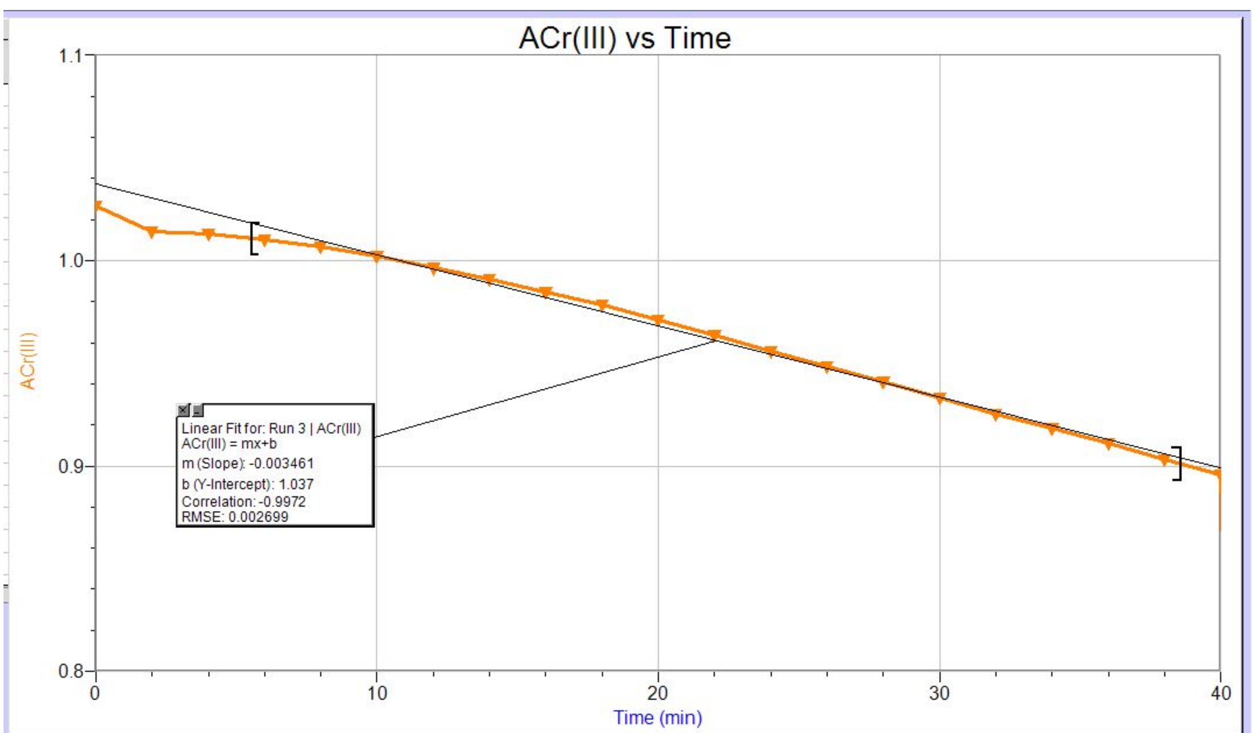
Log of Absorbance of Cr(III) vs Time
Log ACr(III)
0.16
0.15
0.14
0
10
20
30
40
Time (min)

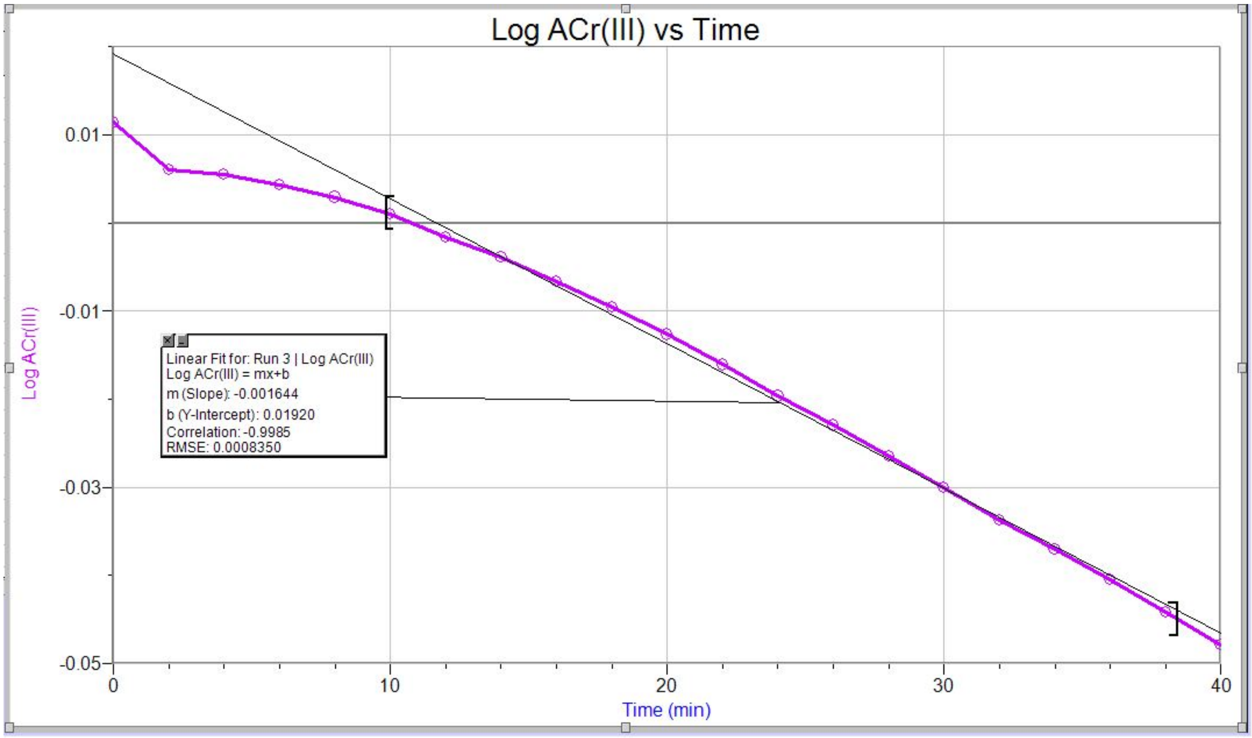


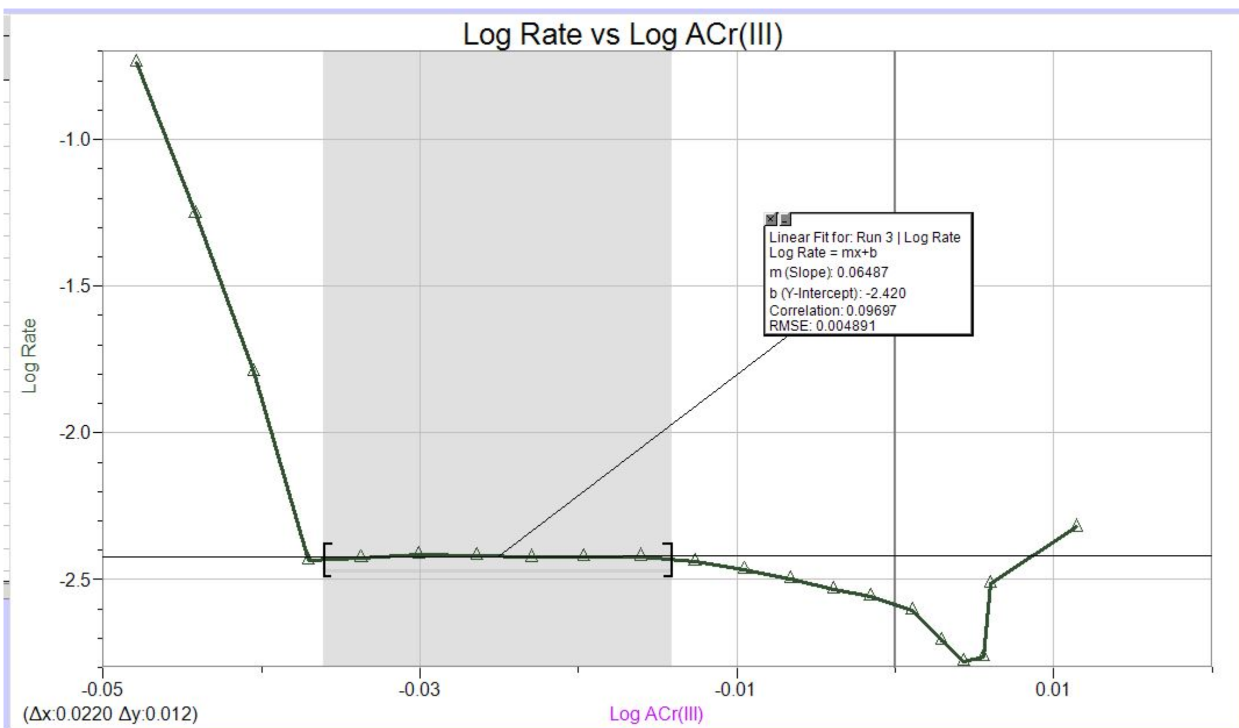
Log of Rate vs Log of Absorbance of Cr (III)
Log Rate
-0.5
-1.0
-1.5
-2.0
-2.5
0.14
0.15
0.16
Log ACr(III)

At pH of 4.5

	Run 3						
	Time (min)	Trans @ 576.5 nm (%)	A	ACr(III)	Log ACr(III)	Rate	Log Rate
2	2	82.985	0.081	1.014	0.006	0.00306	-2.514
3	4	82.767	0.082	1.013	0.006	0.00172	-2.763
4	6	82.232	0.085	1.010	0.004	0.00166	-2.780
5	8	81.621	0.088	1.007	0.003	0.00195	-2.709
6	10	80.808	0.093	1.002	0.001	0.00248	-2.606
7	12	79.686	0.099	0.996	-0.002	0.00277	-2.558
8	14	78.730	0.104	0.991	-0.004	0.00293	-2.533
9	16	77.606	0.110	0.985	-0.007	0.00318	-2.497
10	18	76.447	0.117	0.978	-0.010	0.00341	-2.467
11	20	75.214	0.124	0.971	-0.013	0.00364	-2.439
12	22	73.906	0.131	0.964	-0.016	0.00379	-2.421
13	24	72.575	0.139	0.956	-0.020	0.00379	-2.422
14	26	71.372	0.146	0.949	-0.023	0.00376	-2.425
15	28	70.142	0.154	0.941	-0.026	0.00382	-2.418
16	30	68.887	0.162	0.933	-0.030	0.00384	-2.416
17	32	67.659	0.170	0.925	-0.034	0.00373	-2.428
18	34	66.570	0.177	0.918	-0.037	0.00367	-2.436
19	36	65.464	0.184	0.911	-0.040	0.0161	-1.794
20	38	64.308	0.192	0.903	-0.044	0.0556	-1.255
21	40	63.184	0.199	0.896	-0.048	0.183	-0.738
22	42	8.027	1.095	0.000		0.325	-0.489
23							

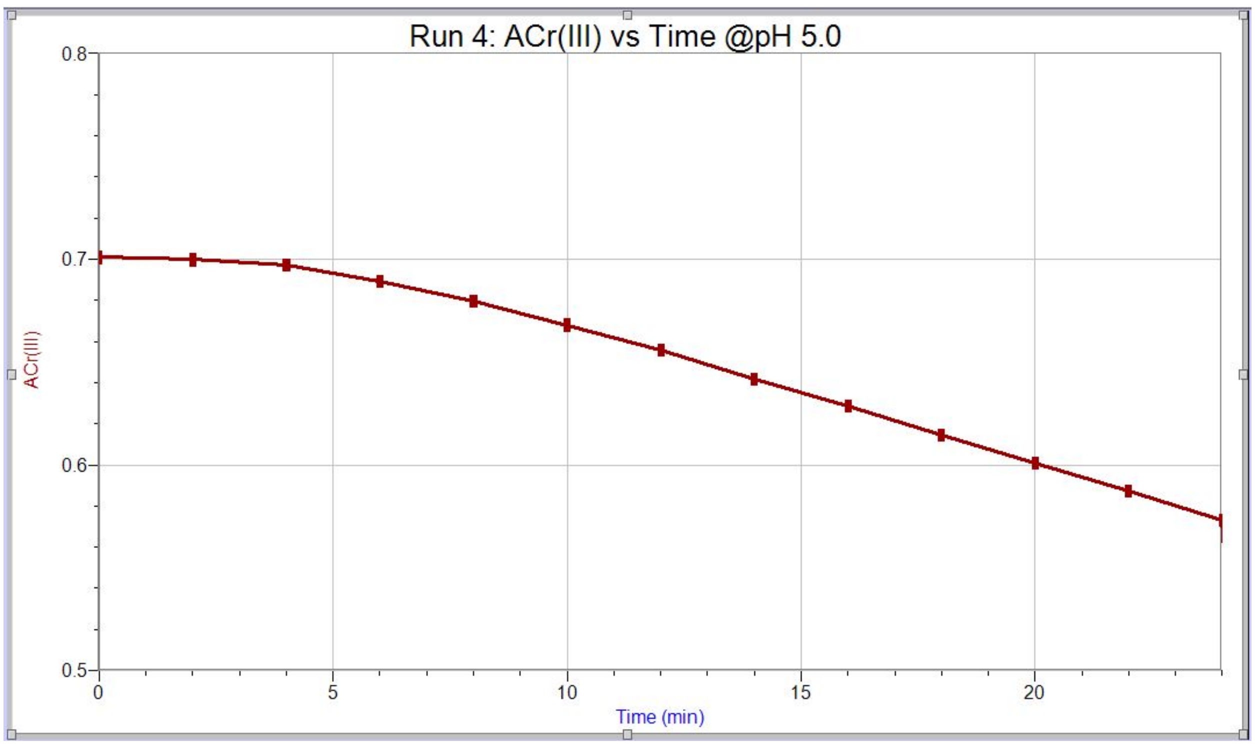



Log ACr(III) vs Time
Linear Fit for: Run 3 | Log ACr(III)
Log ACr(III) = mx+b
m (Slope): -0.001644
b (Y-Intercept): 0.01920
Correlation: -0.9985
RMSE: 0.0008350
Log ACr(III)
Time (min)
0.01
-0.01
-0.03
-0.05
0
10
20
30
40

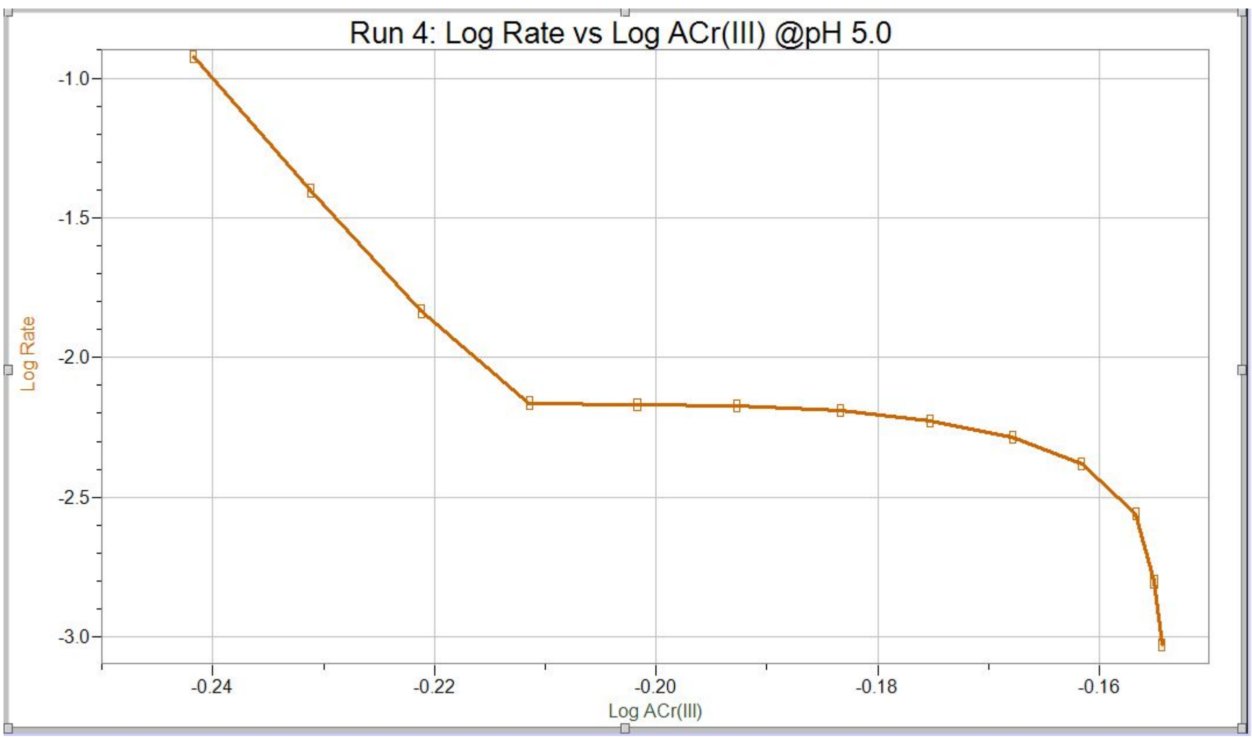

Log Rate vs Log ACr(III)
Linear Fit for: Run 3 | Log Rate
Log Rate = mx+b
m (Slope): 0.06487
b (Y-Intercept): -2.420
Correlation: 0.09697
RMSE: 0.004891
Log Rate
Log ACr(III)
-1.0
-1.5
-2.0
-2.5
-0.05
-0.03
-0.01
0.01
(Δx:0.0220 Δy:0.012)

At pH of 5.0

	Run 4						
	Time (min)	Trans @ 576.5 nm (%)	A	ACr(III)	Log ACr(III)	Rate	Log Rate
1	0	85.295	0.069	0.701	-0.154	0.000936	-3.029
2	2	85.067	0.070	0.700	-0.155	0.00158	-2.802
3	4	84.543	0.073	0.697	-0.157	0.00276	-2.560
4	6	83.035	0.081	0.689	-0.162	0.00416	-2.381
5	8	81.180	0.091	0.679	-0.168	0.00519	-2.284
6	10	79.065	0.102	0.668	-0.175	0.00592	-2.228
7	12	76.846	0.114	0.656	-0.183	0.00646	-2.190
8	14	74.407	0.128	0.642	-0.193	0.00671	-2.173
9	16	72.194	0.141	0.629	-0.202	0.00679	-2.168
10	18	69.913	0.155	0.615	-0.211	0.00687	-2.163
11	20	67.743	0.169	0.601	-0.221	0.0146	-1.834
12	22	65.648	0.183	0.587	-0.231	0.0396	-1.403
13	24	63.552	0.197	0.573	-0.242	0.120	-0.922
14	26	16.972	0.770	0.000		0.209	-0.680




Run 4: Log ACr(III) vs Time @pH 5.0
Log ACr(III)
-0.16
-0.18
-0.20
-0.22
-0.24
0
5
10
15
20
Time (min)


Run 4: Log Rate vs Log ACr(III) @pH 5.0
Log Rate
-1.0
-1.5
-2.0
-2.5
-3.0
-0.24
-0.22
-0.20
-0.18
-0.16
Log ACr(III)

Calculations:

Absorbance at pH of 4.0

$A = \log\left(\frac{100}{80.865}\right)$

A = 0.092

Absorbance at pH of 4.5 = 0.081

Absorbance at pH of 5.0 = 0.070

Amount of unreacted Cr(III)

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

$A_{Cr(III)}$ at pH 4.0= 1.528 - 0.092 = 1.436

$A_{Cr(III)}$ at pH 4.5= 1.013

$A_{Cr(III)}$ at pH of 5.0= 0.700

Logarithm of Cr(III)

$\log(A_{Cr(III)})$ at pH 4.0= 0.157

$\log(A_{Cr(III)})$ at pH 4.5=0.006

$\log(A_{Cr(III)})$ at pH 5.0= -0.155

Discussion:

The temperature and volume are important for this lab. The temperature is driving the reaction, acting as the catalyst. The reaction would take much longer if there was no temperature increase. However, since it is just a catalyst it is not involved in any calculations. The volume is also important. The amount of volume that is in the cuvette is important, having too little or too much solution in it will mess with the spectrometers parameters and give inaccurate values. Also, having enough solution for all three trails to run to completion is important.

In theory, it is possible to reproduce the data, it would just take the exact same time, and circumstances. Trial 3 ran a little shorter than the other two, (only 26 minutes) so that is a factor that needs to be taken into consideration. Also, the exact volumes would be needed as well as the correct volume in the cuvette also determines the accuracy of the spectrometer.

Taking the instantaneous rate of the graphs is dependant on how accurate the data points from the spectrometer are. This is important as this lab is done in a span of 40 minutes, and usually is done in the span of six hours. This adds sources of error, resulting in results that are not ass accurate. The $A_{Cr(III)}$ vs t graphs are supposed to be completely linear, and are not, and the instantaneous rates are the cause of this.

The partial order for this reaction is one, and is a first order reaction. This means that the partial order with respect to the hydrogen ion would be one.

Conclusion:

In conclusion, the partial order for this reaction is one, and the amount of unreacted $A_{Cr(III)}$ for pHs 4.0, 4.5, and 5.0 are 1.436g, 1.013g, and 0.700g respectively.