Percent Transmittance and Absorbance of Various Reactions with different pH Levels

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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 P.Sipa

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

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CHM1311 Section C

Demonstrators:
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Introduction:

This experiment was conducted to find the partial order with respect to the chromium ion. In this experiment, numerous reaction mixtures were prepared at different pH levels. Before we could commence the experiment, it was necessary to calibrate the SpectroVis. To do this we filled a plastic cuvette with the pH 4.5 EDTA solution. While waiting for the SpectroVis to heat up, we placed exactly 4.6mL of the pH 4.5 EDTA solution in a test tube. We then added 5 drops of chromium nitrate solution to the test tube and placed the test tube into boiling water until it turned to a dark purple colour. Once the SpectroVis had heated up we put the cuvette with the pH 4.5 EDTA solution into the SpectroVis and finished the calibration. We then removed the cuvette and removed the original pH 4.5 EDTA solution and put in the test tube solution. We then inserted the cuvette back into the SpectroVis and determined the wavelength of maximum absorbance. It was found that the wavelength was 546.20 nm.

Once the calibration was finished, we could begin the experiment. We conducted this experiment three different times with three different pH levels of the EDTA solution. Firstly a pH of 4.0 was used, then a pH of 4.5, and finally a pH of 5.0. The first step of the experiment was to obtain approximately 10mL of the EDTA solution and place it into a 50mL graduated cylinder. Once in the graduated cylinder, the exact volume was measured then placed into a test tube. We then started LabQuest 2 at t=0 and immediately added two drops of the chromium nitrate solution into the test tube. After we mixed the solution by flicking the bottom of the test tube, we quickly transferred the mixture into the cuvette and placed it into the SpectroVis. The SpectroVis recorded the absorbance and percent transmittance over the next forty minutes. During those forty minutes, the test tube that was containing the rest of the mixture was placed into boiling water. After ten minutes of boiling it was removed and cooled to room temperature. After forty minutes the cuvette was removed and emptied. We quickly put the remaining solution that had been heated into the cuvette, and placed it into the SpectroVis. The SpectroVis recorded for two minutes with the new solution.

These experiments allow for us to observe and calculate many things. Firstly it allows for us to observe the formation of a coloured complex over a period of time. It also allows for us to determine the progression of the reaction using the ability of the coloured complex to absorb light of certain intensity. We can then plot the measured absorbances as a function of the time of reaction. Furthermore, we can determine the instantaneous rate of reaction at a fixed pH using the above graph and also plot the calculated rate as a function of the concentration. We can determine the partial order of the reaction with respect to one of the reactants. Lastly, we can show that the reaction generally follows pseudo first-order kinetics. All of these things will be accomplished and shown in this lab report.

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

Materials:

-50 mL graduated cylinder
-test tube
-cuvette
-spectrophotometer
-hotplate
-250 mL beaker
-50 mL beaker
-600 mL beaker

Procedure: Refer to ""If it were done… Then 'Twere well it were done quickly" Chemical Kinetics"

Observations:

Trial	**1**	**2**	**3**
Volume of EDTA (mL)	9.9	9.9	9.9
pH	4.0	4.5	5.0
Molarity of Cr $(NO_3)_3$	1.0	1.0	1.0
Amount of Cr $(NO_3)_3$	2 drops	2 drops	2 drops
Wavelength, λ (nm)	546.20	546.20	546.20
% Transmittance at 40 minutes	50.024	40.896	22.894
% Transmittance at 42 minutes	0.662	0.682	0.858
Absorbance at 40 minutes	0.30083	0.38832	0.64027
Absorbance at 42 minutes	2.1792	2.1659	2.0664

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

Experiment #1: (pH of 4.0 EDTA solution)

-high percent transmittance after the first forty minutes
-low absorbance after the first forty minutes
-EDTA is clear and colourless
-Cr $(NO_3)_3$ is very dark purple

Experiment #2: (pH of 4.5 EDTA solution)

-medium percent transmittance after the first forty minutes
-low absorbance after the first forty minutes
-EDTA is clear and colourless
- Cr $(NO_3)_3$ is very dark purple

Experiment #3: (pH of 5.0 EDTA solution)

-low percent transmittance after the first forty minutes
-higher absorbance after the first forty minutes
-EDTA is clear and colourless
- Cr $(NO_3)_3$ is very dark purple

Calculations:

pH 4.0 (trial 1)

A_∞= absorbance at 42 minutes
= 2.1792
$A_{Cr\ (III)} = A_\infty - A_t$ (at 20 seconds)
= 2.1792 – 1.993
= 0.1862
Rate = - [derivative (A Cr (III))] (at 20 seconds)
= 0.00556

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

pH 4.5 (trial 2)

A_∞= absorbance at 42 minutes
= 2.1659
$A_{Cr\ (III)} = A_\infty - A_t$ (at 20 seconds)
= 2.1659 – 0.22047
= 1.94543
Rate = - [derivative (A Cr (III))] (at 20 seconds)
= 0.01002

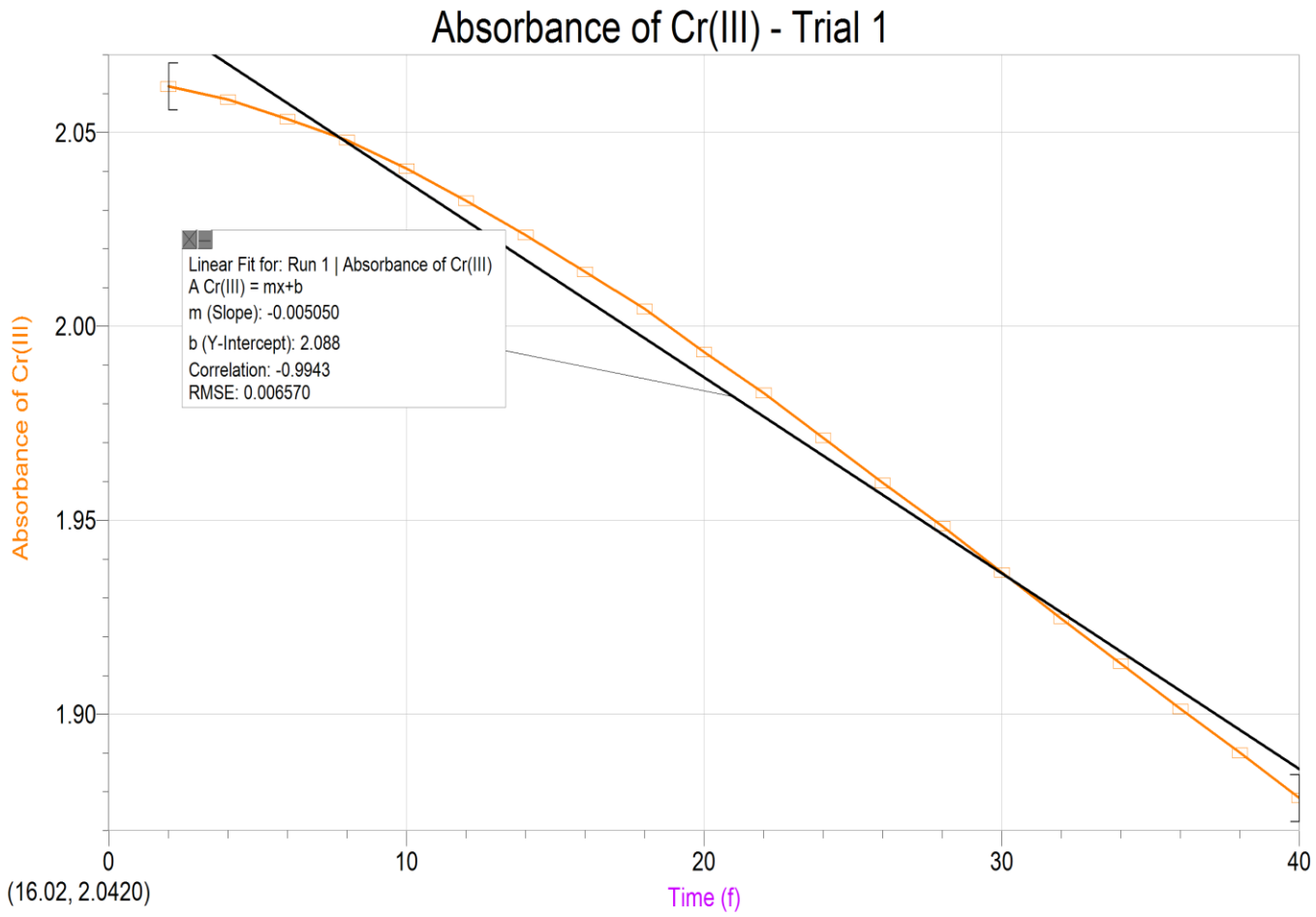
pH 5.0 (trial 3)

A_∞= absorbance at 42 minutes
= 2.0664
$A_{Cr\ (III)} = A_\infty - A_t$ (at 20 seconds)
= 2.0664 – 0.46823
= 1.59817
Rate = - [derivative (A Cr (III))] (at 20 seconds)
= 0.01318

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

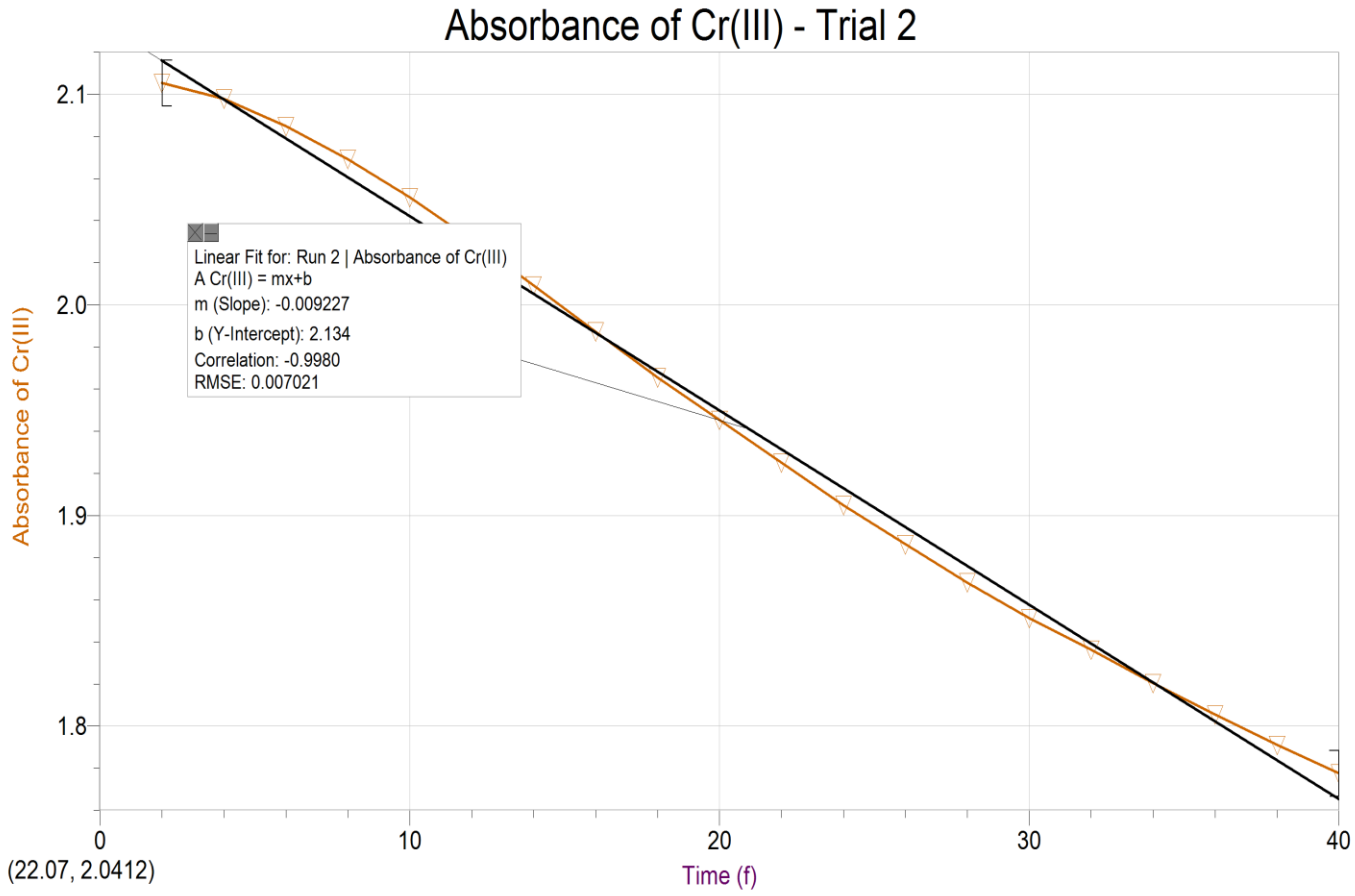
Graphs:

For trial number 1, the pH of 4.0 EDTA solution was used. The graph below shows the absorbance of Cr (III) from 2.0s to 40.0s for trial 1. The absorbance decreases as time goes by because the concentration of Cr (III) decreases.



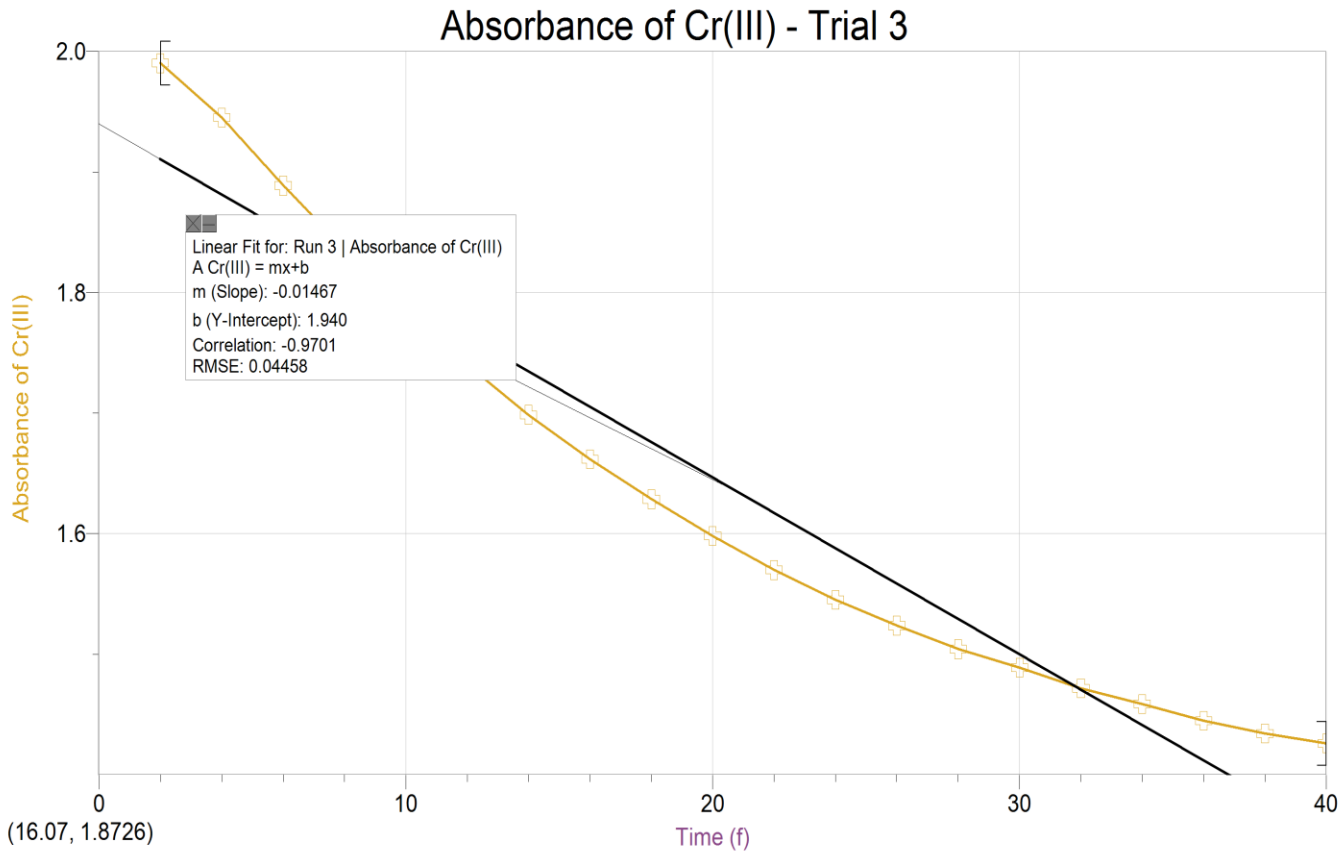
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

For trial number 2, the 4.5 of pH EDTA solution was used. The graph below shows the absorbance of Cr (III) from 2.0s to 40.0s for trial 2. The absorbance decreases as time goes by because the concentration of the Cr (III) decreases.



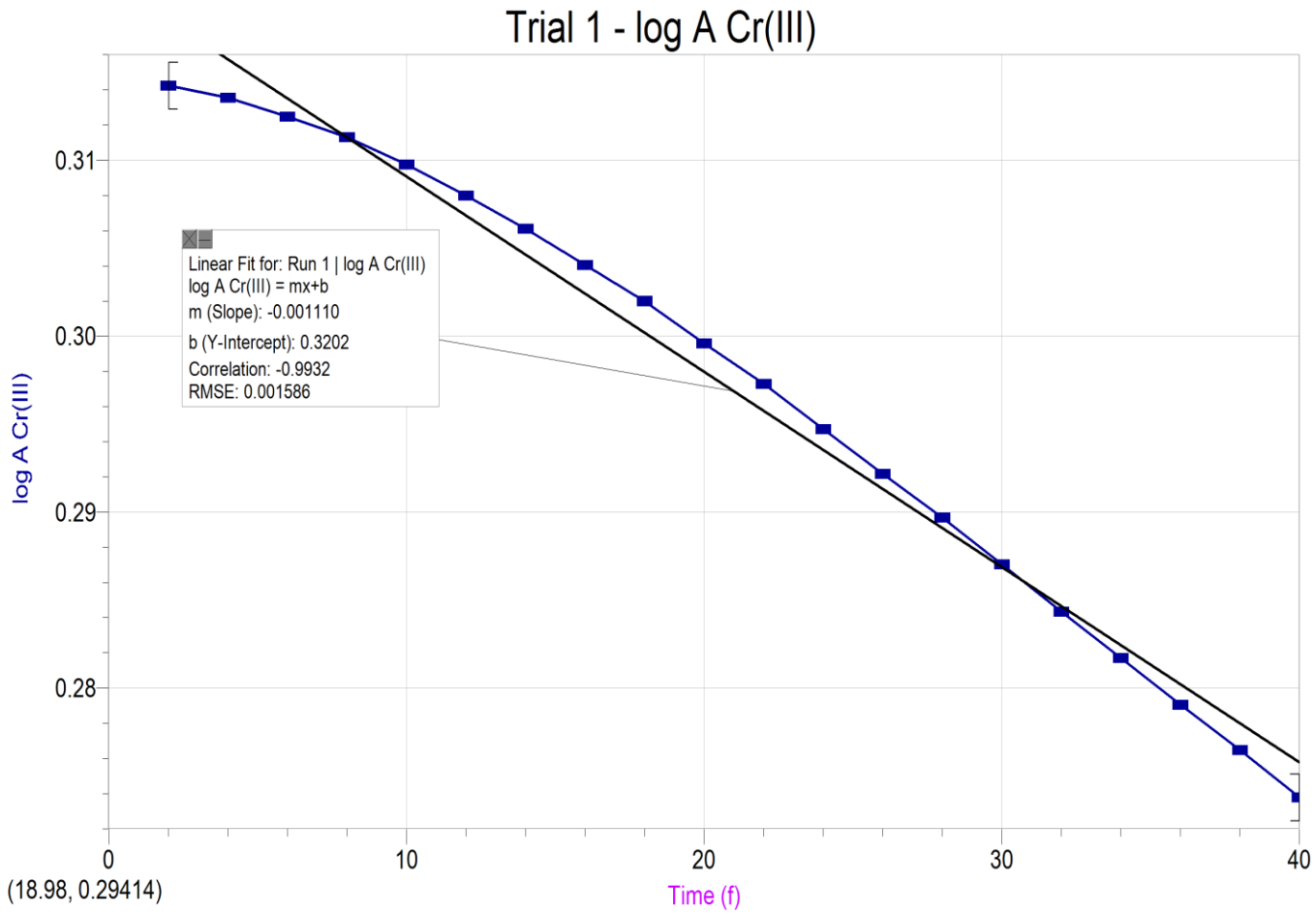
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

For trial number 3, pH of 5.0 EDTA solution was used. The graph below shows the absorbance of Cr (III) from 2.0s to 40.0s for trial 3. The absorbance decreases as time goes by because the concentration of the Cr (III) decreases.



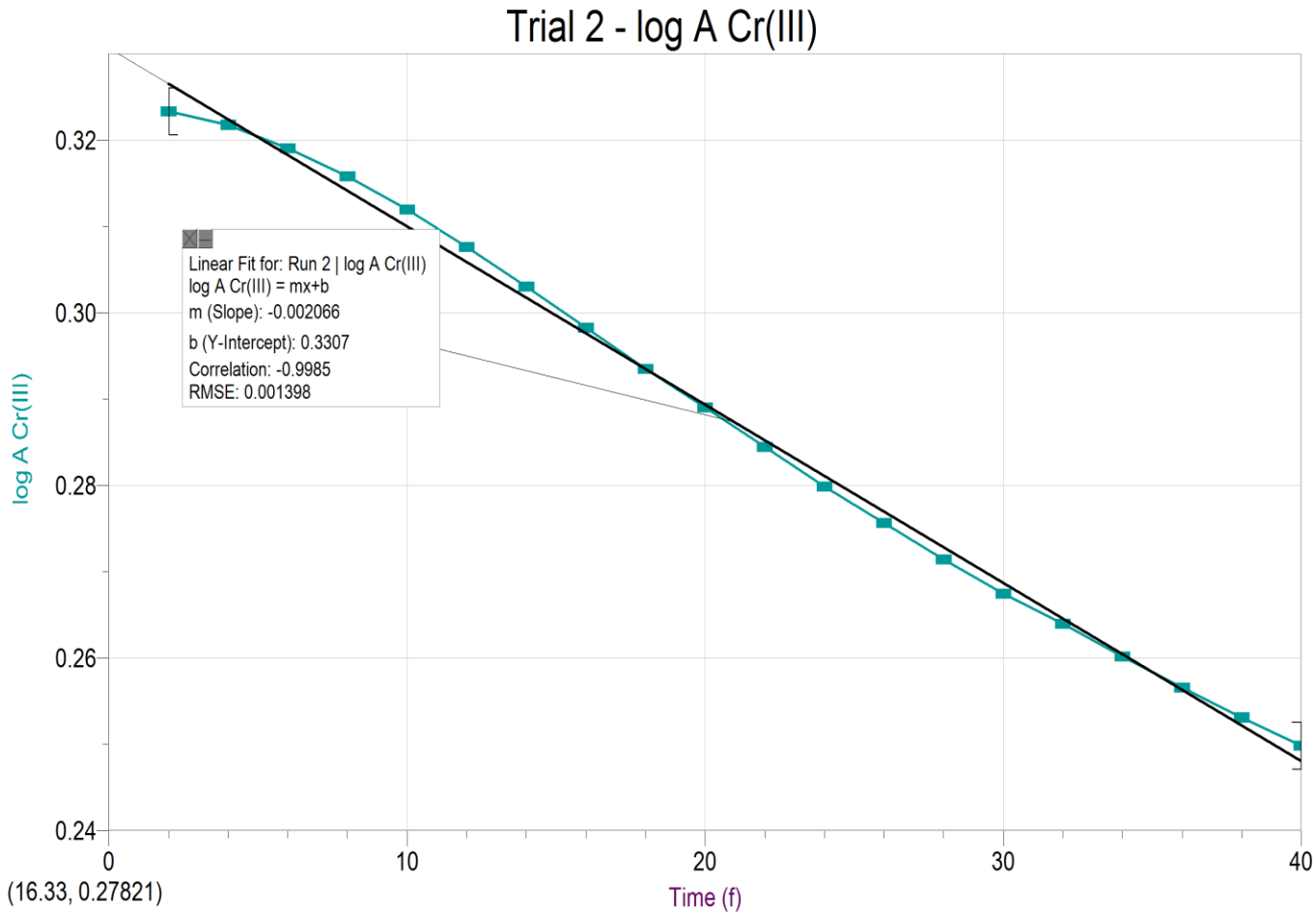
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares the log of absorbance of Cr (III) with time for trial 1, where pH of 4.0 EDTA was used. We graph the log of absorbance of Cr (III) with time because we assume this is a first order reaction and therefore this graph should be a linear plot. Due to error it is slightly off.



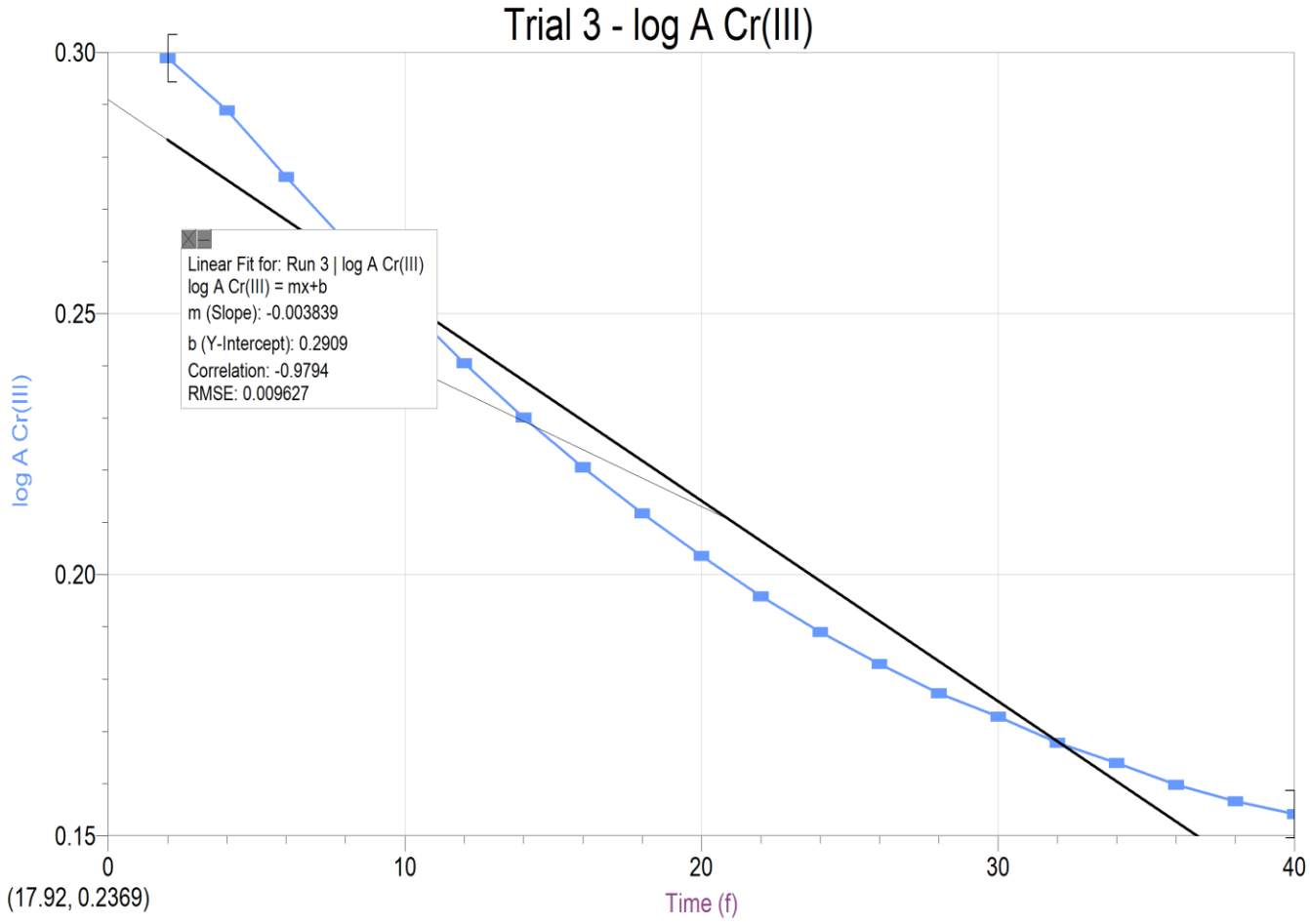
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares the log of absorbance of Cr (III) with time for trial 1, where pH of 4.5 EDTA was used. We graph the log of absorbance of Cr (III) with time because we assume this is a first order reaction and therefore this graph should be a linear plot. Due to error it is slightly off.



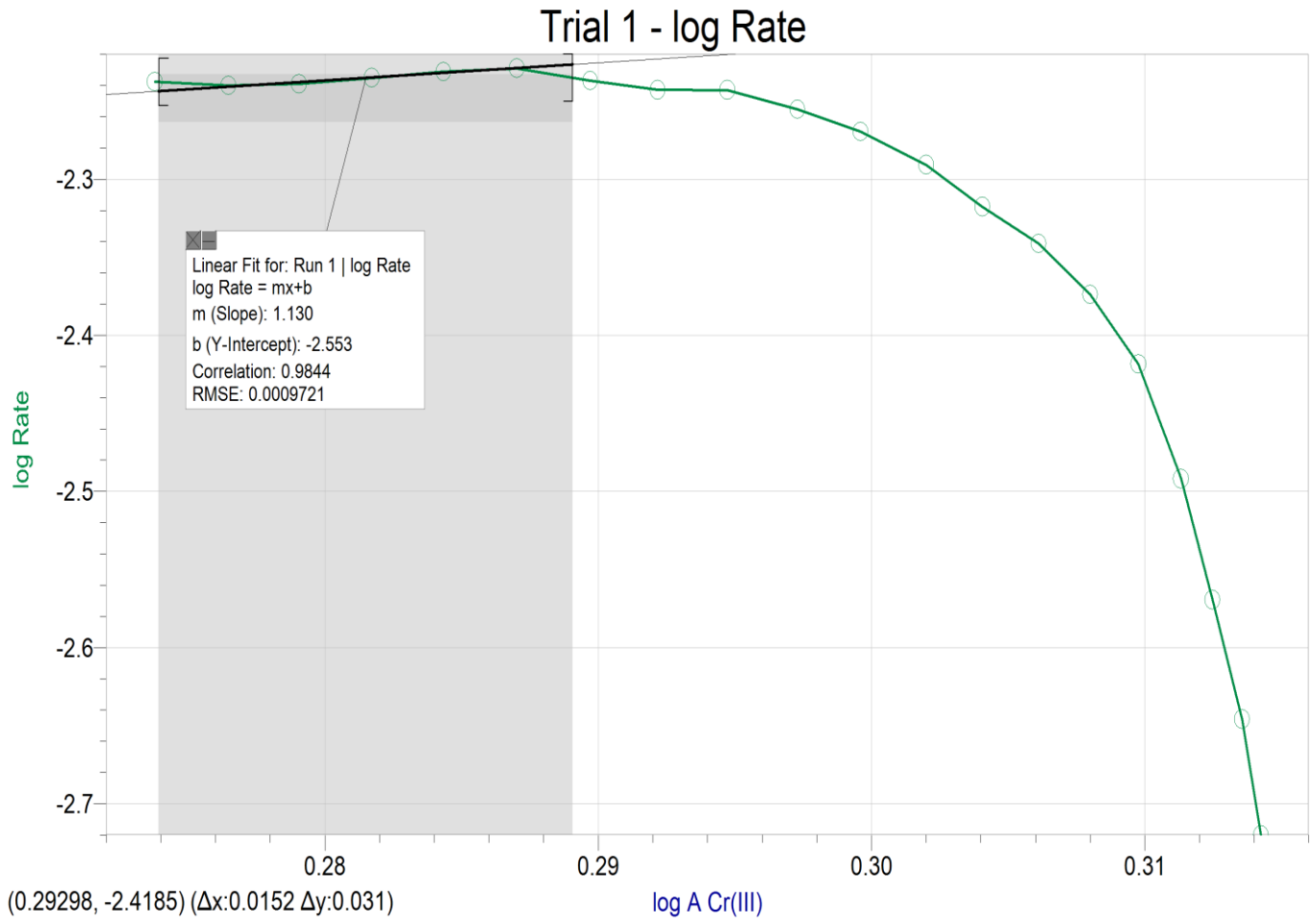
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares the log of absorbance of Cr (III) with time for trial 1, where pH of 5.0 EDTA was used. We graph the log of absorbance of Cr (III) with time because we assume this is a first order reaction and therefore this graph should be a linear plot. Due to error it is slightly off.



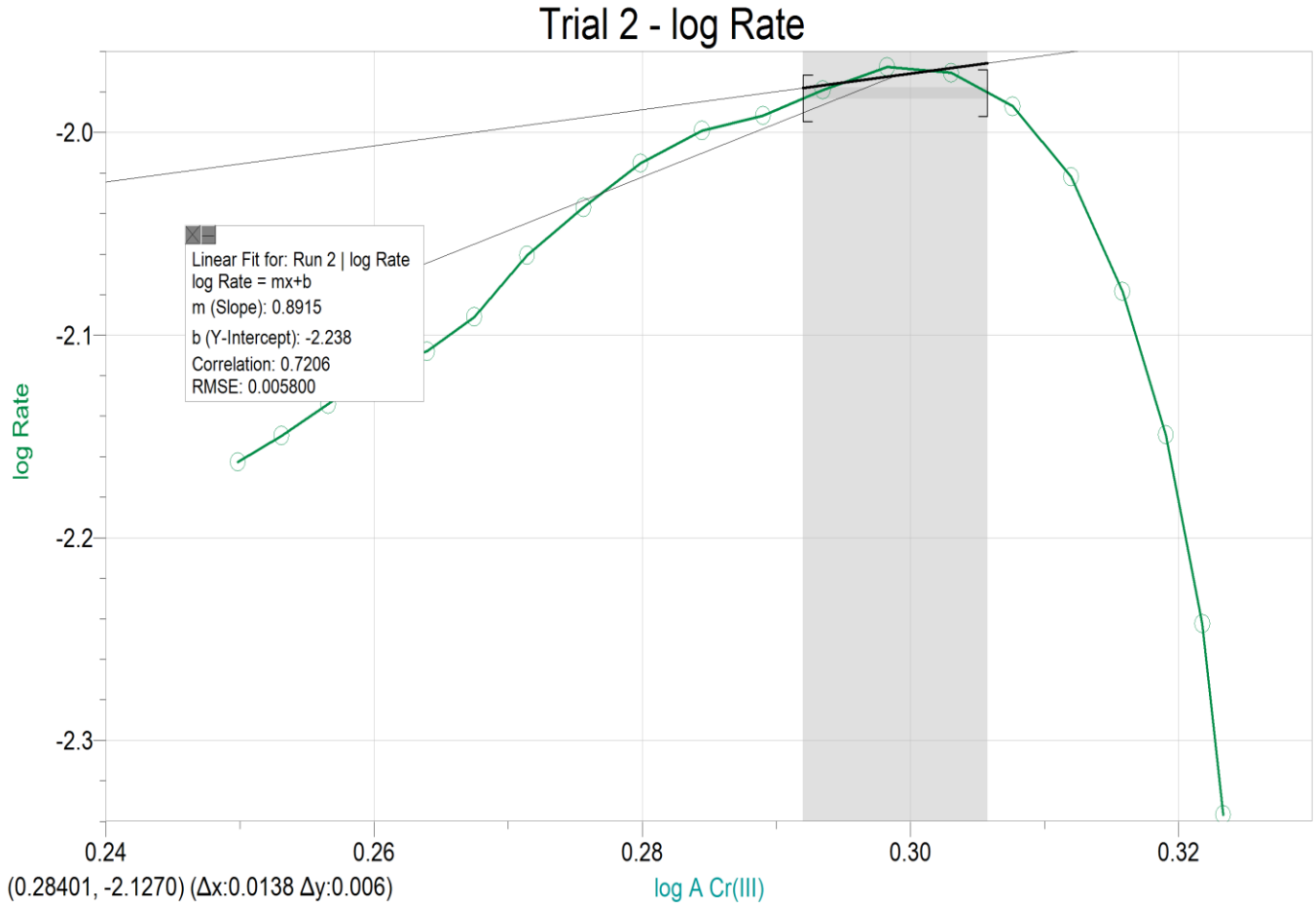
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares log (rate) and the log of the absorbance of Cr (III) for trial 1, where pH of 4.0 EDTA was used. Due to experimental error, only a portion of the graph was used to find the slope. In this portion it was found to be approximately 1. From this information we can determine that the partial order of this reaction is 1.



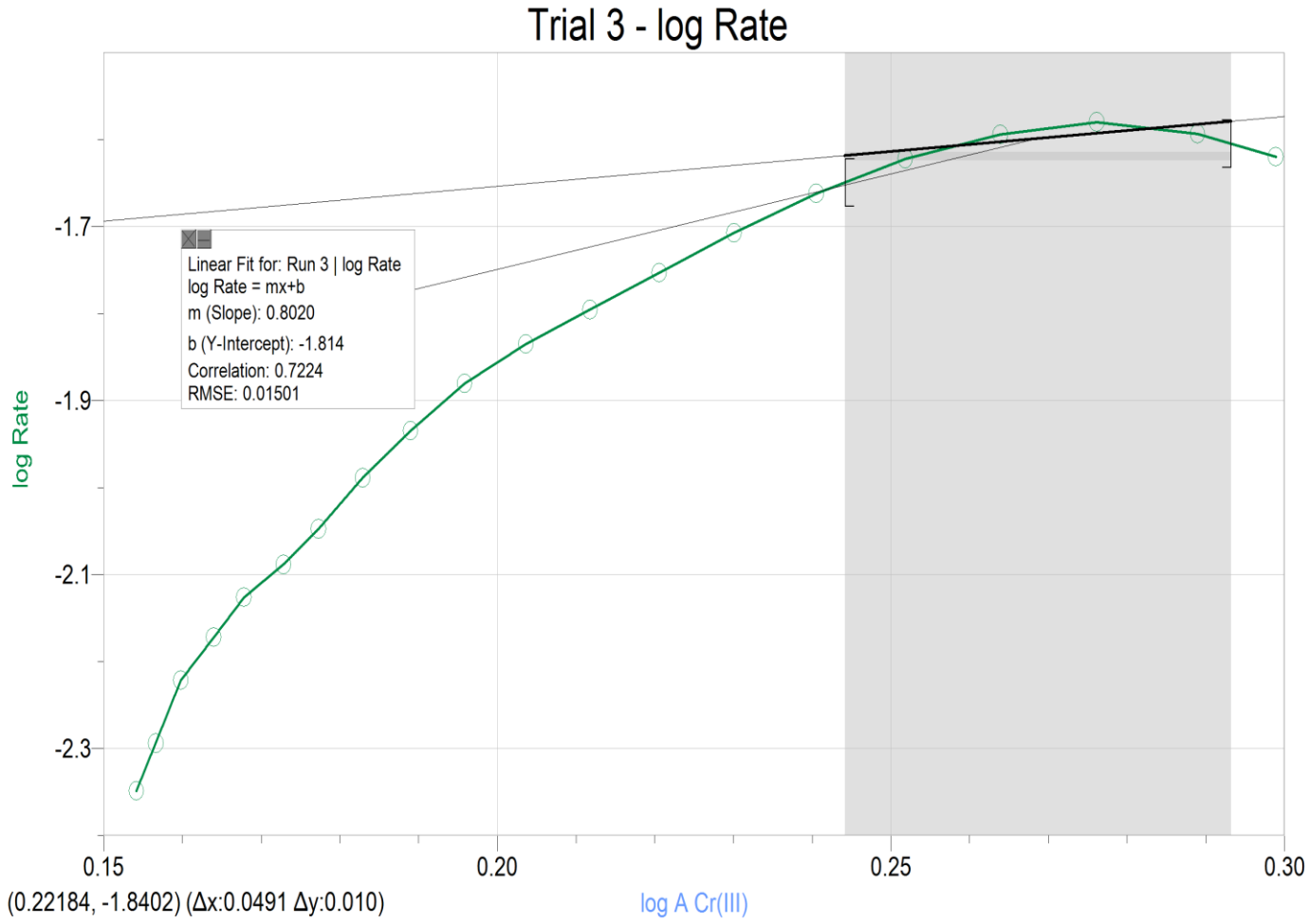
Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares log (rate) and the log of the absorbance of Cr (III) for trial 2, where pH of 4.5 EDTA was used. Due to experimental error, only a very small portion of the graph was used to find the slope. In this portion it was found to be approximately 1. From this information we can determine that the partial order of this reaction is 1.



Percent Transmittance and Absorbance of Various Reactions with different pH Levels

This graph compares log (rate) and the log of the absorbance of Cr (III) for trial 3, where pH of 5.0 EDTA was used. Due to experimental error, only a portion of the graph was used to find the slope. In this portion it was found to be approximately 1. From this information we can determine that the partial order of this reaction is 1.



Percent Transmittance and Absorbance of Various Reactions with different pH Levels

Discussion:

As previously stated, this experiment was conducted to find the partial order with repsect to the chromium ion. It was found that for this reaction the partial order was 1. We were able to determine this by using logger pro, and graphing log of the absorbance of Cr (III) by time and also graphing the log rate by the log of absorbance of Cr (III). In the last three graphs, it can be observed that the slope is approximately 1 for every trial. This tells us that the partial order is 1.

$$\text{Rate} = k' [\text{Cr (III)}]^m$$

$$k' = k[\text{EDTA}]^n[H^+]^p$$

$$\log \text{Rate} = \log k' + m \log[\text{Cr (III)}]$$

$$y = b + m x$$

From these equations, we can see how the slope allows for us to determine the partial order.

There were a couple experimental errors that occurred, and swayed the data so that it was not completely exact. Firstly, it was necessary to stop recording the data after only 40 minutes and therefore we were only able to take information from that 40 minute time span. Lastly, during the calibration, which determined the wavelength used, it was required to heat a solution until it turned a certain darkness of purple. It is possible that it was either heated for too long or too little and therefore the wavelength used for the rest of the experiment was affected.

Conclusion:

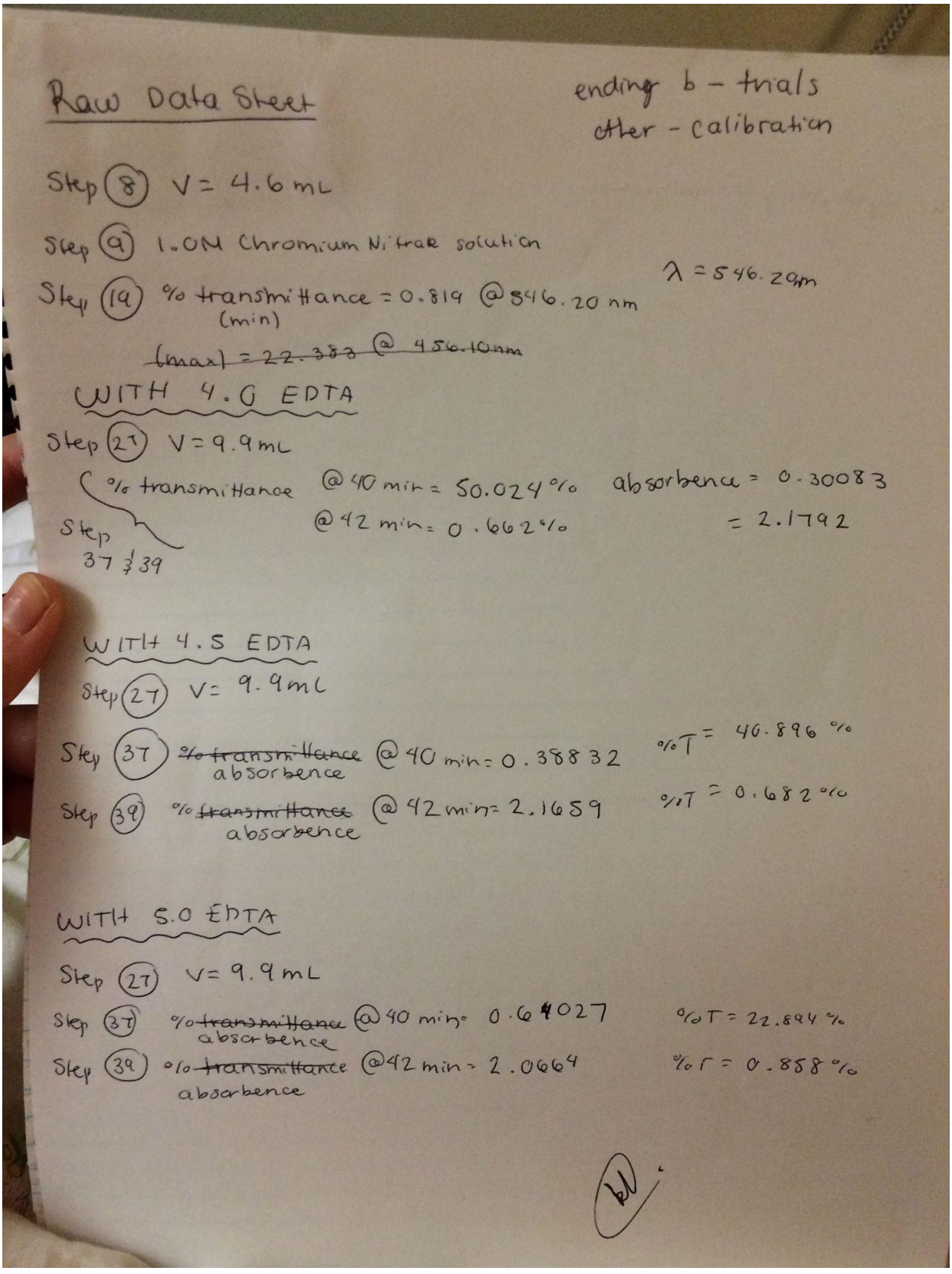
From this experiment we can conclude that the partial order with respect to the Cr (III) ion approximately 1 for the pH of 4.0, pH of 4.5 and pH of 5.0 EDTA. Therefore for this reaction, the partial order is assumed to be 1.

Percent Transmittance and Absorbance of Various Reactions with different pH Levels

Raw Data:

	Run 1			Run 2			Run 3		
	Time (min)	s @ 546.2 (%)	bsorbenc	Time (min)	s @ 546.2 (%)	bsorbenc	Time (min)	s @ 546.2 (%)	bsorbenc
1	0	90.002	0.045746	0	89.559	0.047889	0	89.146	0.049898
2	2	76.317	0.11738	2	87.007	0.060446	2	83.905	0.076214
3	4	75.742	0.12066	4	85.512	0.067973	4	75.642	0.12124
4	6	74.857	0.12577	6	82.970	0.081081	6	66.411	0.17776
5	8	73.921	0.13123	8	80.052	0.096630	8	58.841	0.23032
6	10	72.684	0.13856	10	76.778	0.11476	10	52.411	0.28058
7	12	71.308	0.14686	12	73.242	0.13524	12	47.149	0.32653
8	14	69.883	0.15563	14	69.727	0.15660	14	42.868	0.36787
9	16	68.359	0.16520	16	66.290	0.17855	16	39.387	0.40464
10	18	66.876	0.17473	18	63.044	0.20036	18	36.482	0.43792
11	20	65.195	0.18579	20	60.191	0.22047	20	34.023	0.46823
12	22	63.627	0.19636	22	57.445	0.24075	22	31.872	0.49659
13	24	61.941	0.20802	24	54.827	0.26100	24	30.115	0.52122
14	26	60.314	0.21958	26	52.534	0.27956	26	28.660	0.54272
15	28	58.793	0.23067	28	50.383	0.29772	28	27.400	0.56225
16	30	57.191	0.24267	30	48.458	0.31463	30	26.448	0.57761
17	32	55.642	0.25460	32	46.821	0.32956	32	25.427	0.59470
18	34	54.176	0.26620	34	45.132	0.34552	34	24.679	0.60766
19	36	52.739	0.27787	36	43.607	0.36045	36	23.894	0.62170
20	38	51.384	0.28917	38	42.184	0.37486	38	23.326	0.63216
21	40	50.024	0.30083	40	40.896	0.38832	40	22.894	0.64027
22	42	0.662	2.1792	42	0.682	2.1659	42	0.858	2.0664
23									
24									

Percent Transmittance and Absorbance of Various Reactions with different pH Levels



Raw Data Sheet

ending b – trials
other – calibration

Step (8) V = 4.6 mL

Step (9) 1.0M Chromium Nitrate solution

Step (19) % transmittance = 0.819 @ 546.20 nm (min) λ = 546.20nm

~~(max) = 22.383 @ 456.10nm~~

WITH 4.0 EDTA

Step (27) V = 9.9mL

Step 37 & 39: % transmittance @ 40 min = 50.024 % absorbence = 0.30083
@ 42 min = 0.662 % = 2.1792

WITH 4.5 EDTA

Step (27) V = 9.9mL

Step (37) ~~% transmittance~~ absorbence @ 40 min = 0.38832 %T = 40.896 %

Step (39) % ~~transmittance~~ absorbence @ 42 min = 2.1659 %T = 0.682 %

WITH 5.0 EDTA

Step (27) V = 9.9mL

Step (37) % ~~transmittance~~ absorbence @ 40 min = 0.64027 %T = 22.894 %

Step (39) % ~~transmittance~~ absorbence @ 42 min = 2.0664 %T = 0.858 %