Laboratory Report Form

EXPEIMENT 4: CHEMICAL KINETICS

Course: CHM1311A

Year Taken: 2016

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Student's Initials: EI

Introduction:

To begin with, kinetics is the study of movement(motion) of an object. Therefore, Chemical Kinetics refers to the study of a chemical reaction with respect to its reaction rate. The reaction rate relates to the depletion of reactants (rearrangement of atoms) in which the concentration decreases over a period of time, and at the same time it leads to the formation of products. The pace at which the reaction occurs is called the reaction rate and it depends on the concentration of products which is measured in mol per L. The rate of a reaction can also be determined graphically. The rate of the reaction can be determined the equation be low:

Rate = k [A] ^n [B] ^m for the reaction A + B --> Products

k= rate constant.

The order of reaction is determined by the power n and m; their summation indicates the total order of the reaction. The order of reaction can only be determined experimentally.

In this experiment, Spectrophotometry ("the study of the interaction of electromagnetic radiation with matter") will be highly required to determine transmittance (the intensity of light after it passes through a medium) and absorbance. The relationship between absorbance and transmittance is given by the equation below:

Transmittance (Trans) = Trans% $\div 100\%$

Absorbance (A) = - log Trans

Calculations: Using row 1 in run 1

Calculating from Transmittance to Absorbance:

Given: Trans % @578.2 nm = 92.319% at time = 0 seconds,

Trans = Trans% ÷ 100%

= 92.319% ÷ 100% = 0.92319

Therefore, Absorbance = - log Trans

= -log (0.92319)

= 0.0347

Calculating from Absorbance to Absorbance of Cr III:

At time zero:

ACr (III) = A∞ - At

In run 1 at 0 seconds,

At = 0.035 and A∞ = 1.509

ACr (III) = 1.509 – 0.035 = 1.474

Observation:

ACr (III) at time when time is zero = 1.617 because only Cr III is in the solution. However, ACr (III) at infinite time = 0 because there is no more Cr III at this point of time.

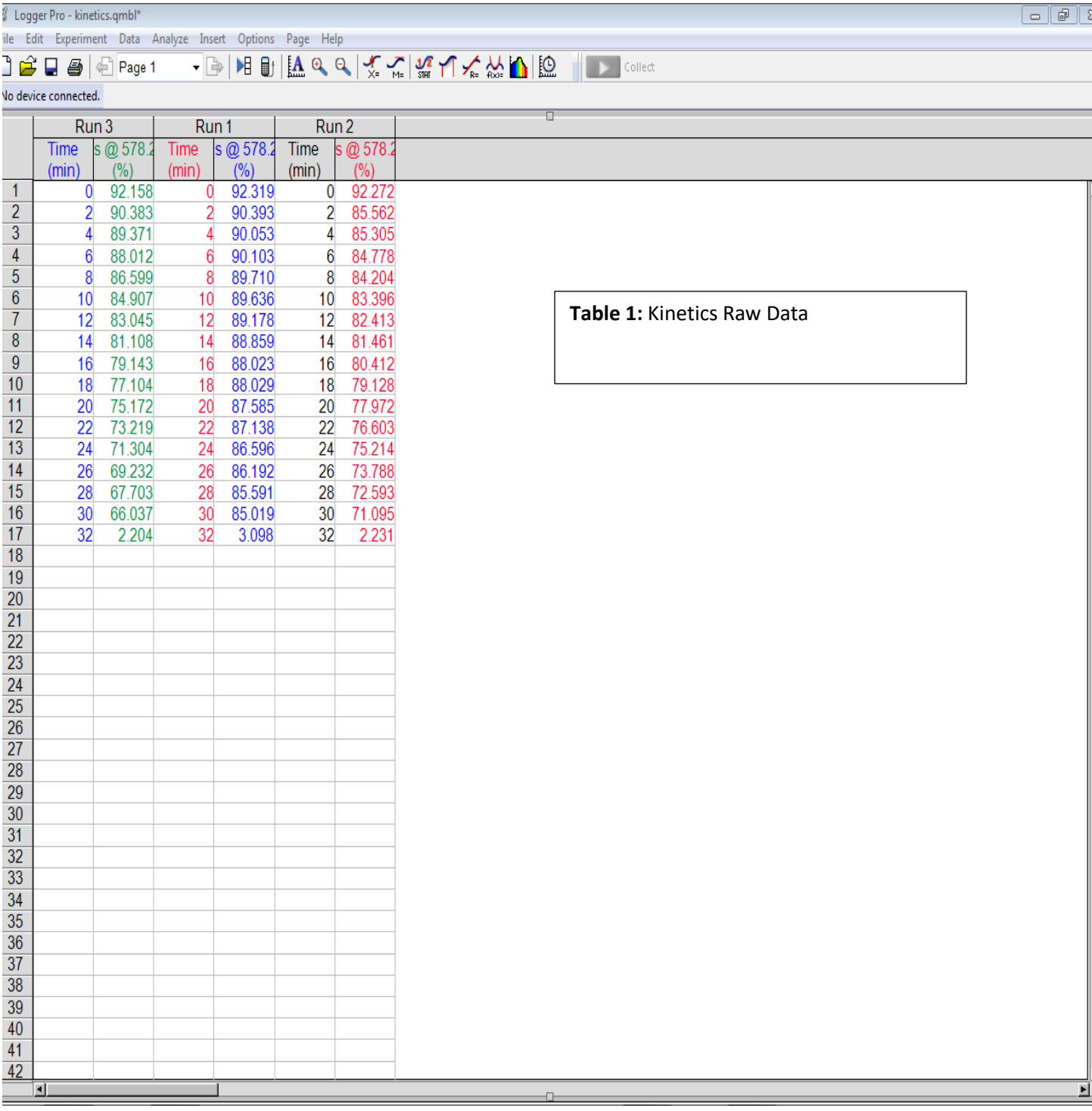
Calculating from ACr III to log of ACr III:

If given that ACr III = 0.035

Log ACr III = log (0.035) = -1.456

Finally: log of the rate = log (rate) = log (0.00348) = -2.458

DATA TABLES:



	Run 3		Run 1		Run 2	
	Time (min)	s @ 578.2 (%)	Time (min)	s @ 578.2 (%)	Time (min)	s @ 578.2 (%)
1	0	92.158	0	92.319	0	92.272
2	2	90.383	2	90.393	2	85.562
3	4	89.371	4	90.053	4	85.305
4	6	88.012	6	90.103	6	84.778
5	8	86.599	8	89.710	8	84.204
6	10	84.907	10	89.636	10	83.396
7	12	83.045	12	89.178	12	82.413
8	14	81.108	14	88.859	14	81.461
9	16	79.143	16	88.023	16	80.412
10	18	77.104	18	88.029	18	79.128
11	20	75.172	20	87.585	20	77.972
12	22	73.219	22	87.138	22	76.603
13	24	71.304	24	86.596	24	75.214
14	26	69.232	26	86.192	26	73.788
15	28	67.703	28	85.591	28	72.593
16	30	66.037	30	85.019	30	71.095
17	32	2.204	32	3.098	32	2.231
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42						

Table 1: Kinetics Raw Data

Table 2:
pH = 4.0

		Run 1 table	pH = 4.0			
Time	Trans %	A(t)	log Acr III	Rate	Log of	A Cr III
(min)	578.2 nm				Rate	
0	92.31923	0.034708	0.168584	0.003482	-2.45812	1.474292
2	90.39269	0.043867	0.165877	0.002195	-2.65855	1.465133
4	90.05278	0.045503	0.165392	0.000907	-3.04256	1.463497
6	90.10297	0.045261	0.165464	0.000568	-3.24552	1.463739
8	89.70965	0.047161	0.1649	0.000562	-3.25031	1.461839
10	89.63599	0.047518	0.164794	0.000712	-3.14768	1.461482
12	89.17809	0.049742	0.164132	0.000957	-3.01925	1.459258
14	88.85872	0.0513	0.163668	0.001179	-2.92832	1.4577
16	88.02323	0.055403	0.162444	0.001006	-2.99756	1.453597
18	88.02938	0.055372	0.162453	0.000802	-3.09598	1.453628
20	87.58538	0.057568	0.161797	0.001032	-2.98636	1.451432
22	87.13827	0.059791	0.161131	0.001167	-2.93281	1.449209
24	86.59623	0.062501	0.160318	0.00122	-2.91379	1.446499
26	86.19178	0.064534	0.159707	0.021237	-1.6729	1.444466
28	85.59106	0.067572	0.158793	0.085164	-1.06974	1.441428
30	85.01873	0.070485	0.157914	0.290548	-0.53678	1.438515

Table 3

		Run 2 Data: pH = 4.5				
Time	Trans %	A(t)	A Cr III	log of	Rate	Log of
(min)	578.2 nm			A Cr III		Rate
0	92.27202	0.03493	1.61707	0.208729	0.01206	-1.91864
2	85.56199	0.067719	1.584281	0.199832	0.007133	-2.1467
4	85.30518	0.069025	1.582975	0.199474	0.002888	-2.53947
6	84.77792	0.071717	1.580283	0.198735	0.001851	-2.73263
8	84.20401	0.074667	1.577333	0.197923	0.001812	-2.74173
10	83.39636	0.078853	1.573147	0.196769	0.002246	-2.64859
12	82.41259	0.084006	1.567994	0.195344	0.002525	-2.59779
14	81.46088	0.089051	1.562949	0.193945	0.002749	-2.56084
16	80.41151	0.094682	1.557318	0.192377	0.003092	-2.50975
18	79.12797	0.10167	1.55033	0.190424	0.003336	-2.47677
20	77.97237	0.108059	1.543941	0.188631	0.003566	-2.4478
22	76.60349	0.115751	1.536249	0.186461	0.003837	-2.41602
24	75.21356	0.123704	1.528296	0.184208	0.003972	-2.40099
26	73.78798	0.132014	1.519986	0.181839	0.024712	-1.60709
28	72.59335	0.139103	1.512897	0.179809	0.091273	-1.03966
30	71.09532	0.148159	1.503841	0.177202	0.305298	-0.51528

Table 4

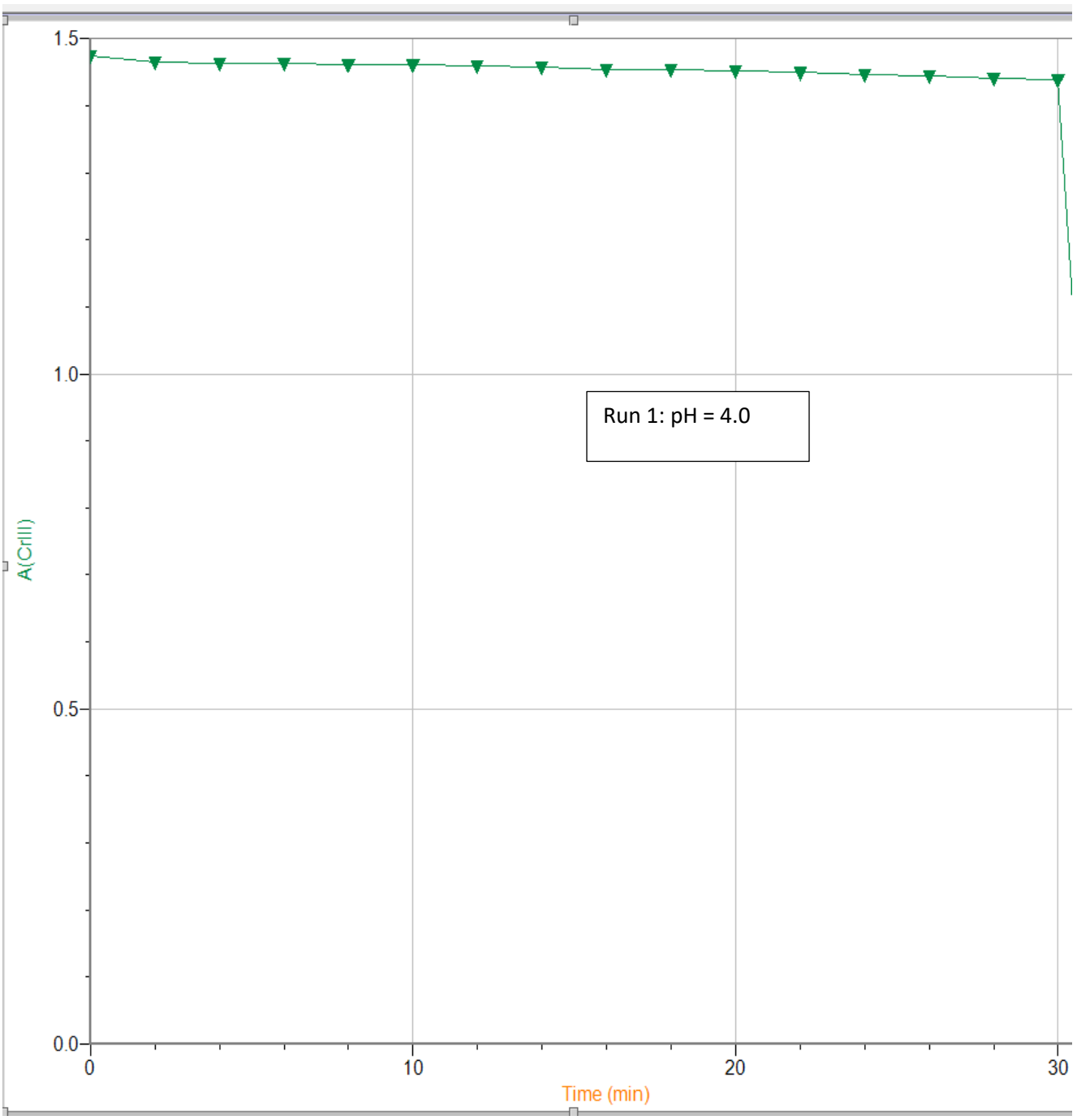
		Run3 Data	pH= 5.0			
Time	Trans %	A(t)	A Cr III	log of	Rate	Log of
(min)	578.2 nm			A Cr III		Rate
0	92.15798	0.035467	1.621533	0.209926	0.003778	-2.42278
2	90.38343	0.043911	1.613089	0.207658	0.003341	-2.47619
4	89.37099	0.048803	1.608197	0.206339	0.003162	-2.50001
6	88.01222	0.055457	1.601543	0.204539	0.003469	-2.45974
8	86.59916	0.062486	1.594514	0.202628	0.003931	-2.40545
10	84.90722	0.071055	1.585945	0.200288	0.004487	-2.34809
12	83.04504	0.080686	1.576314	0.197643	0.004913	-2.30867
14	81.10758	0.090939	1.566061	0.194809	0.005211	-2.2831
16	79.143	0.101587	1.555413	0.191846	0.005444	-2.2641
18	77.10396	0.112923	1.544077	0.188669	0.005565	-2.25451
20	75.17246	0.123941	1.533059	0.185559	0.005649	-2.24801
22	73.21892	0.135377	1.521623	0.182307	0.005759	-2.23965
24	71.30357	0.146889	1.510111	0.179009	0.005868	-2.23149
26	69.23163	0.159695	1.497305	0.17531	0.02597	-1.58553
28	67.7027	0.169394	1.487606	0.172488	0.09083	-1.04177
30	66.03738	0.18021	1.47679	0.169319	0.300538	-0.5221

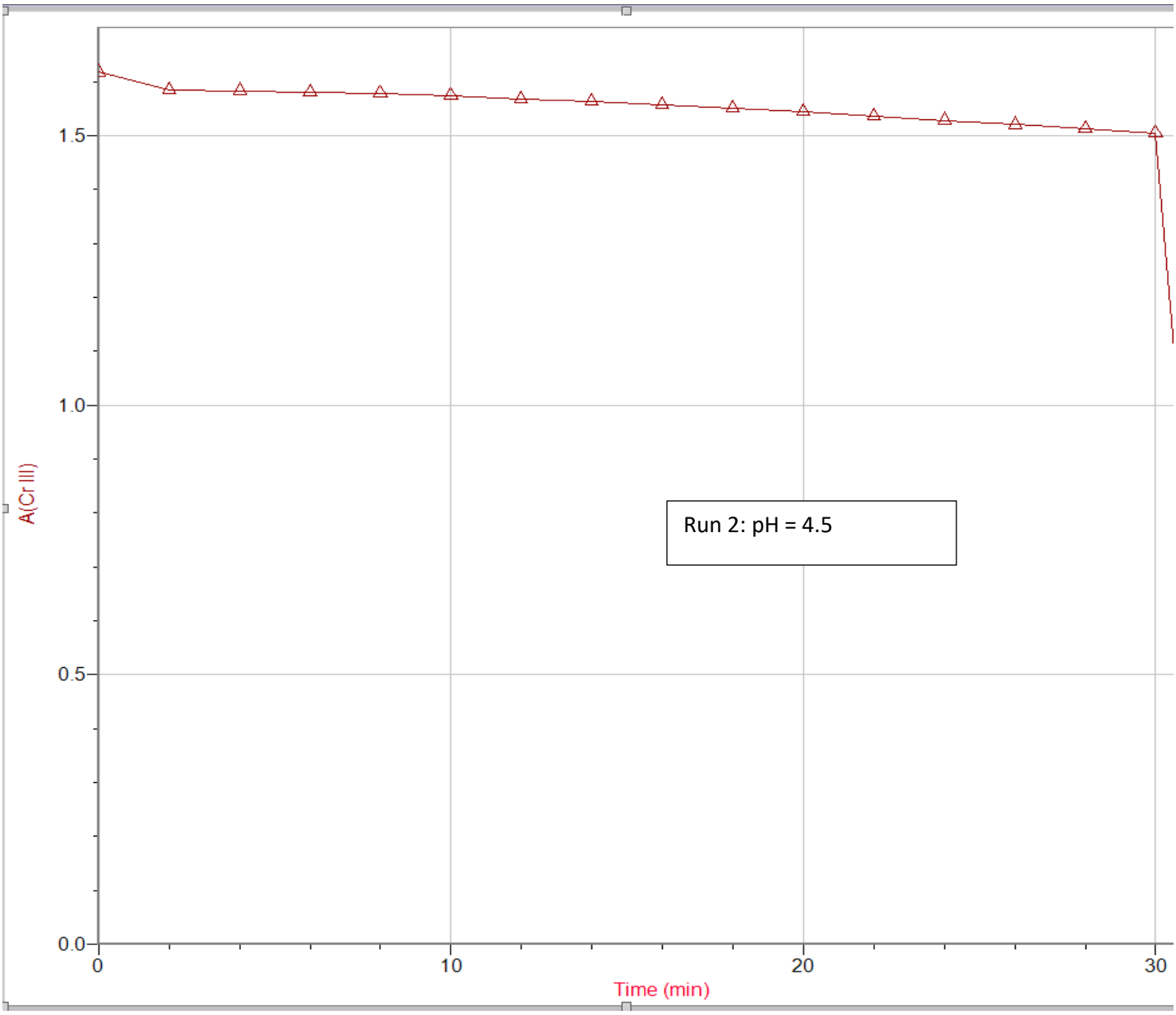
Observations:

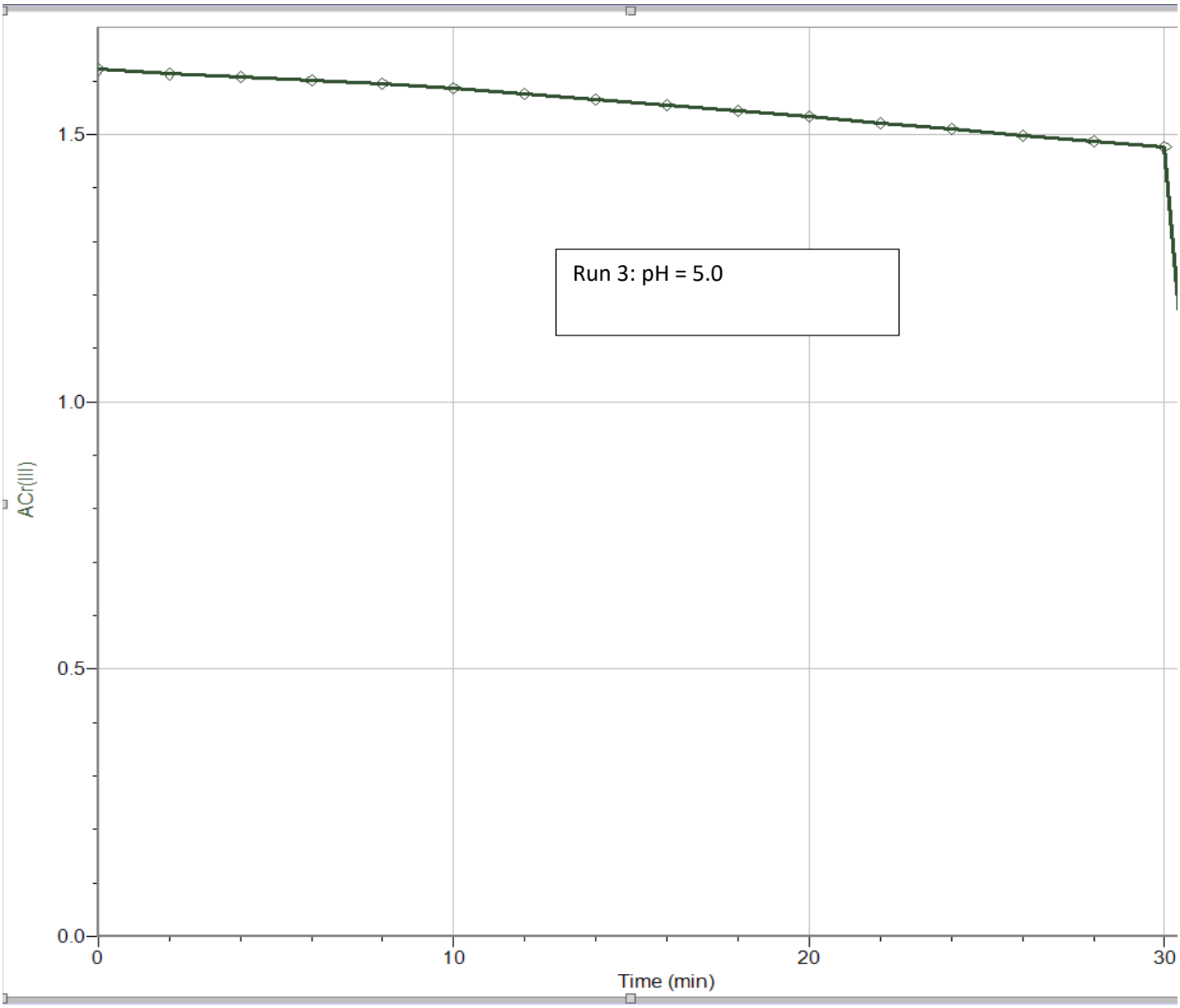
Absorbance increases as time increases. The concentration of Chromium ion decreases over time as it is converted to complex while the natural logarithm function of chromium ion decreases. As the rate increases, its natural logarithm function increases too. The function of the log of ACr III looks linear, and this indicates that the experiment was done in less time than the actual time required for the experiment. The values of the rate are not the same, just as I expected because the rate of reaction changes with the change in the concentration of reactants.

Graphs:

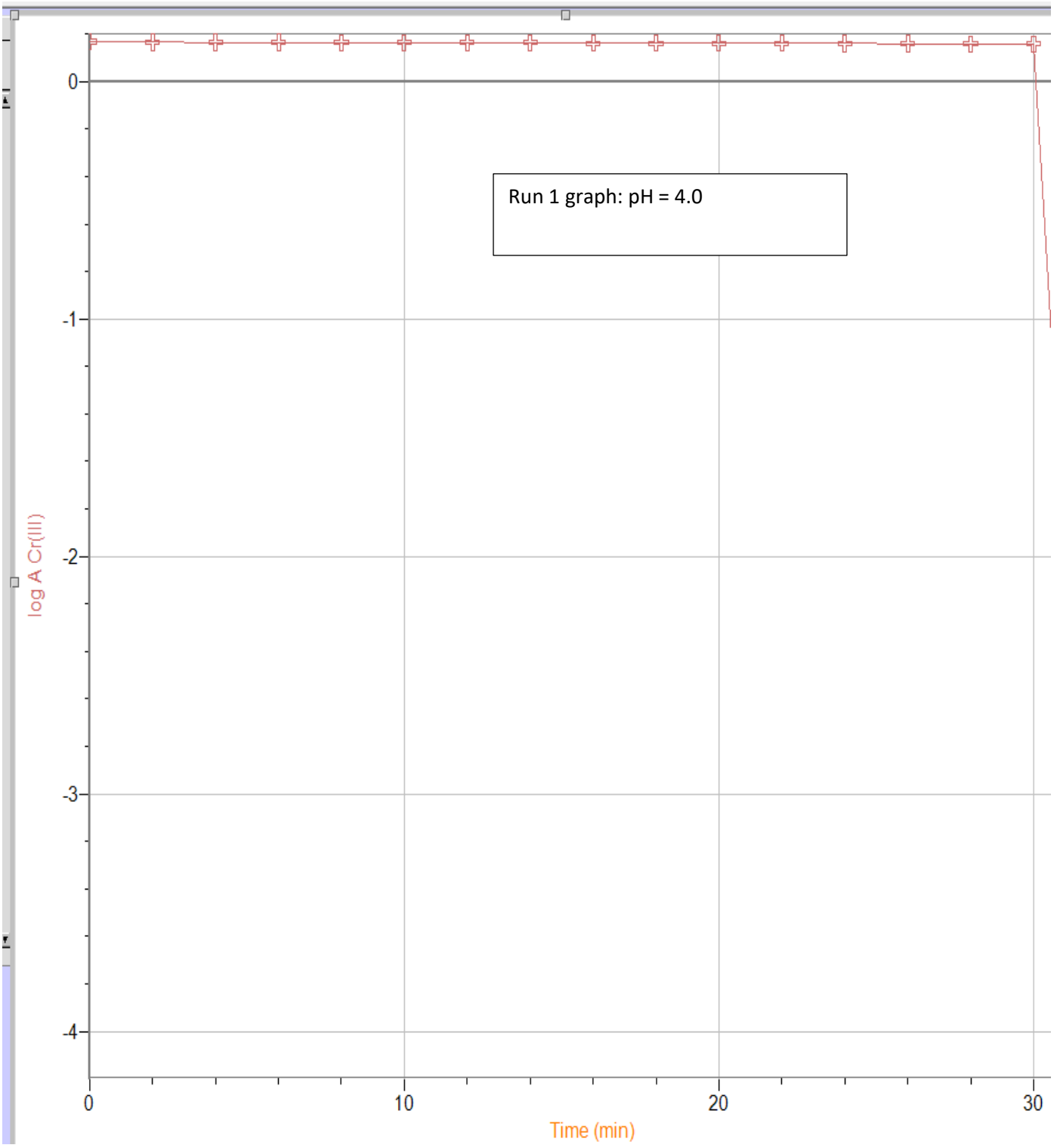
1. **Graphs for ACr III as a function of time for all pH values**

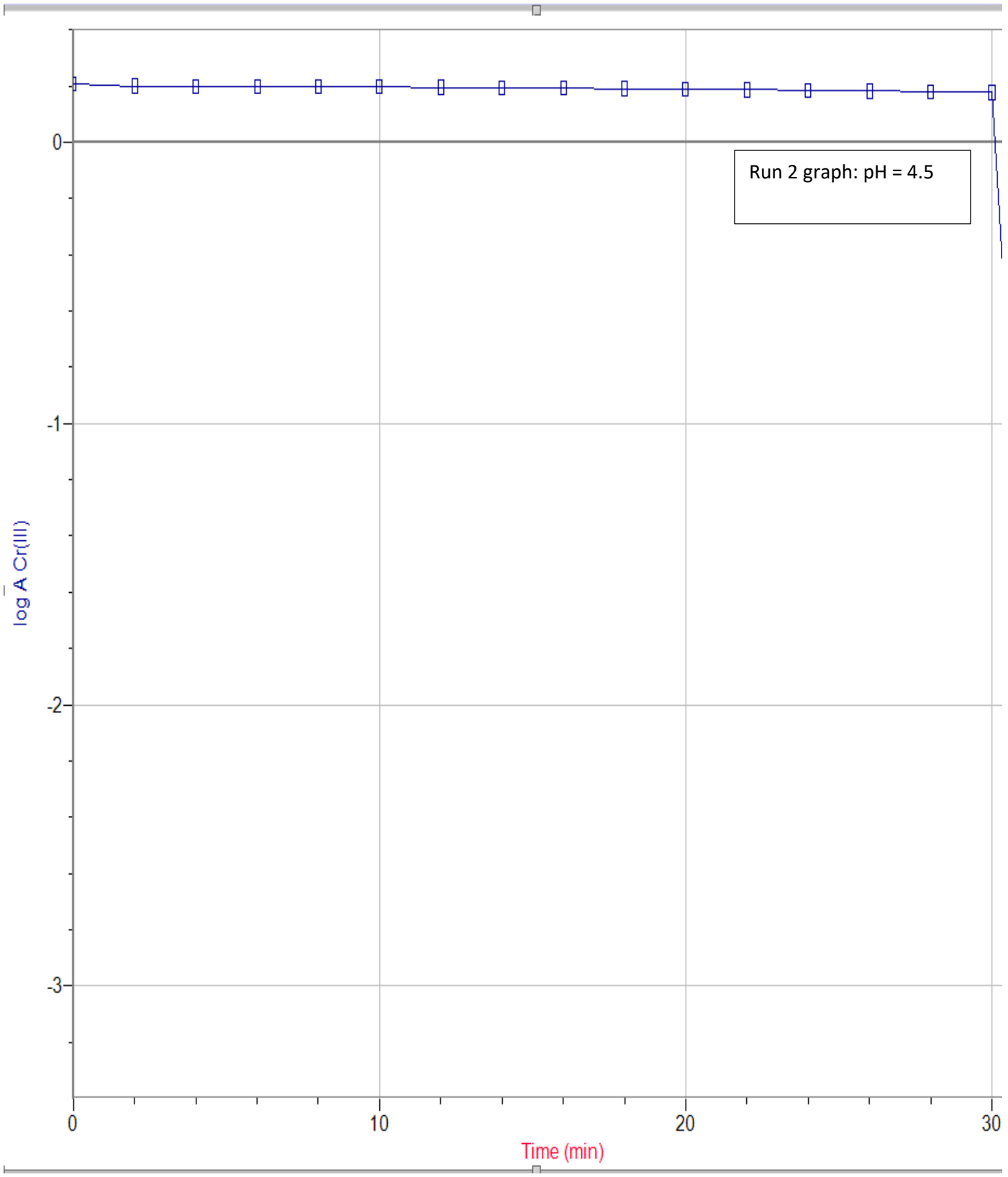

1.5
1.0
0.5
0.0
A(CrIII)
0
10
20
30
Time (min)
Run 1: pH = 4.0

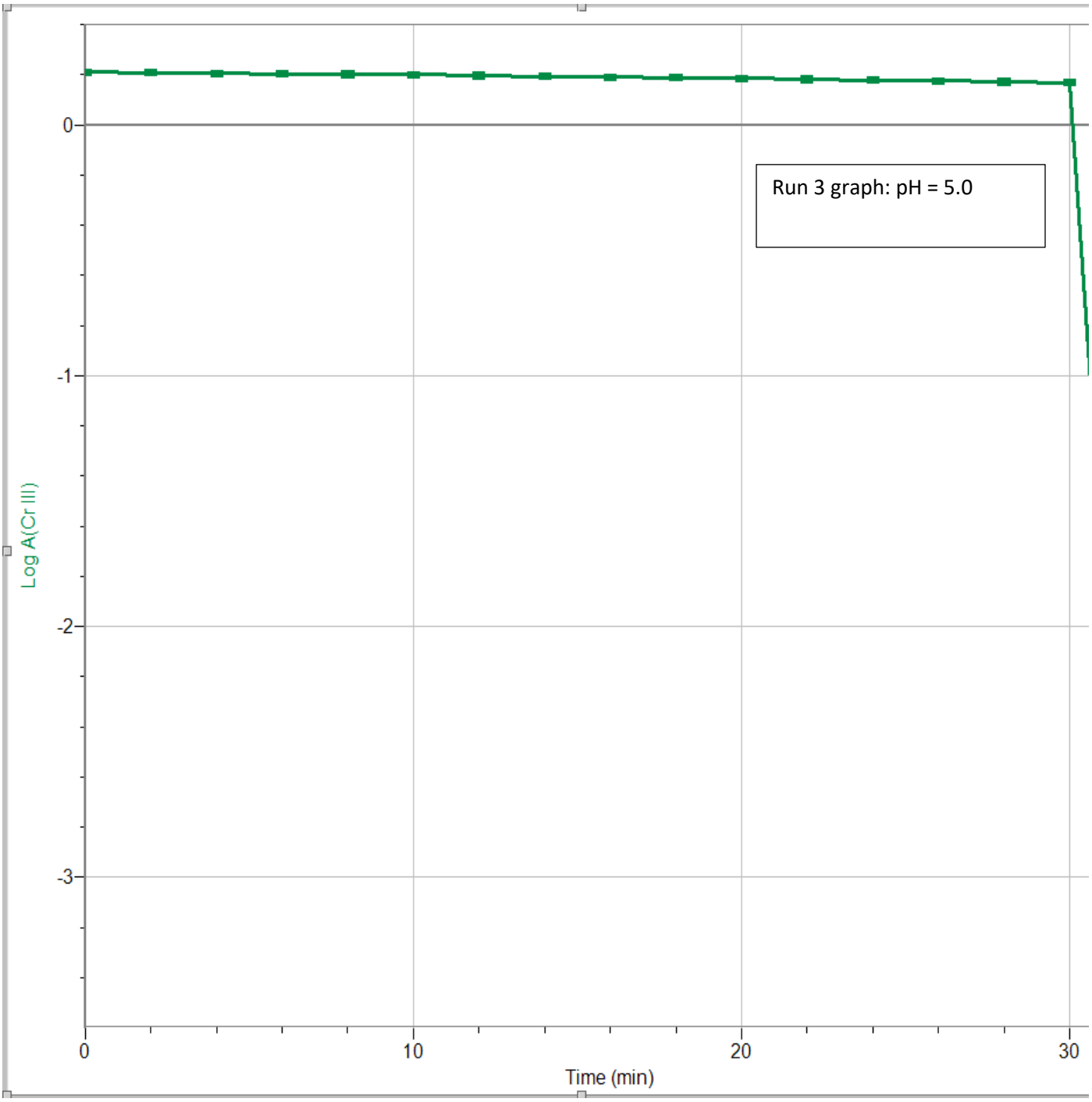

1.5
1.0
0.5
0.0
A(Cr III)
0
10
20
30
Time (min)
Run 2: pH = 4.5


Run 3: pH = 5.0
ACr(III)
1.5
1.0
0.5
0.0
0
10
20
30
Time (min)

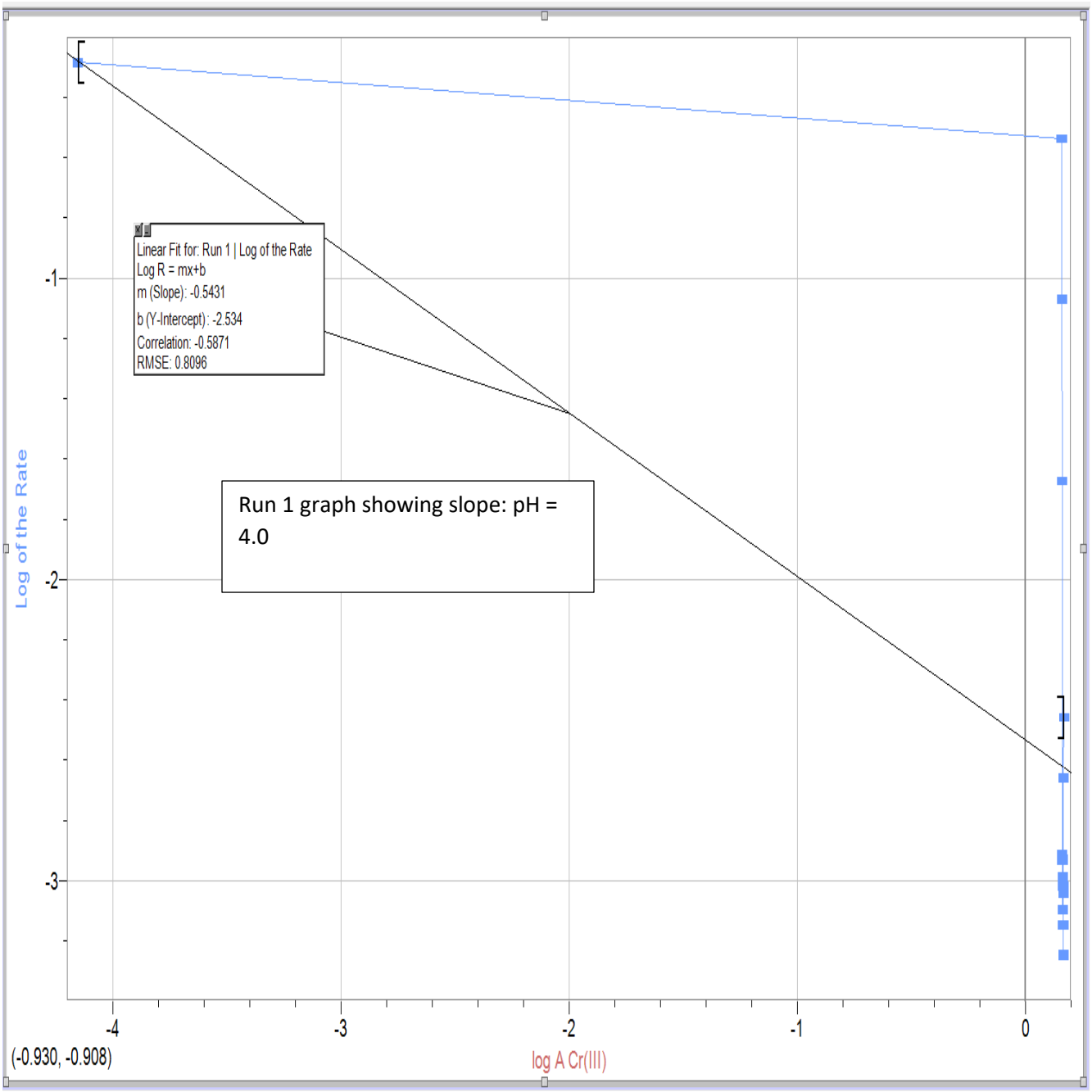
Graphs for plots of log ACr (III) as a function of time:



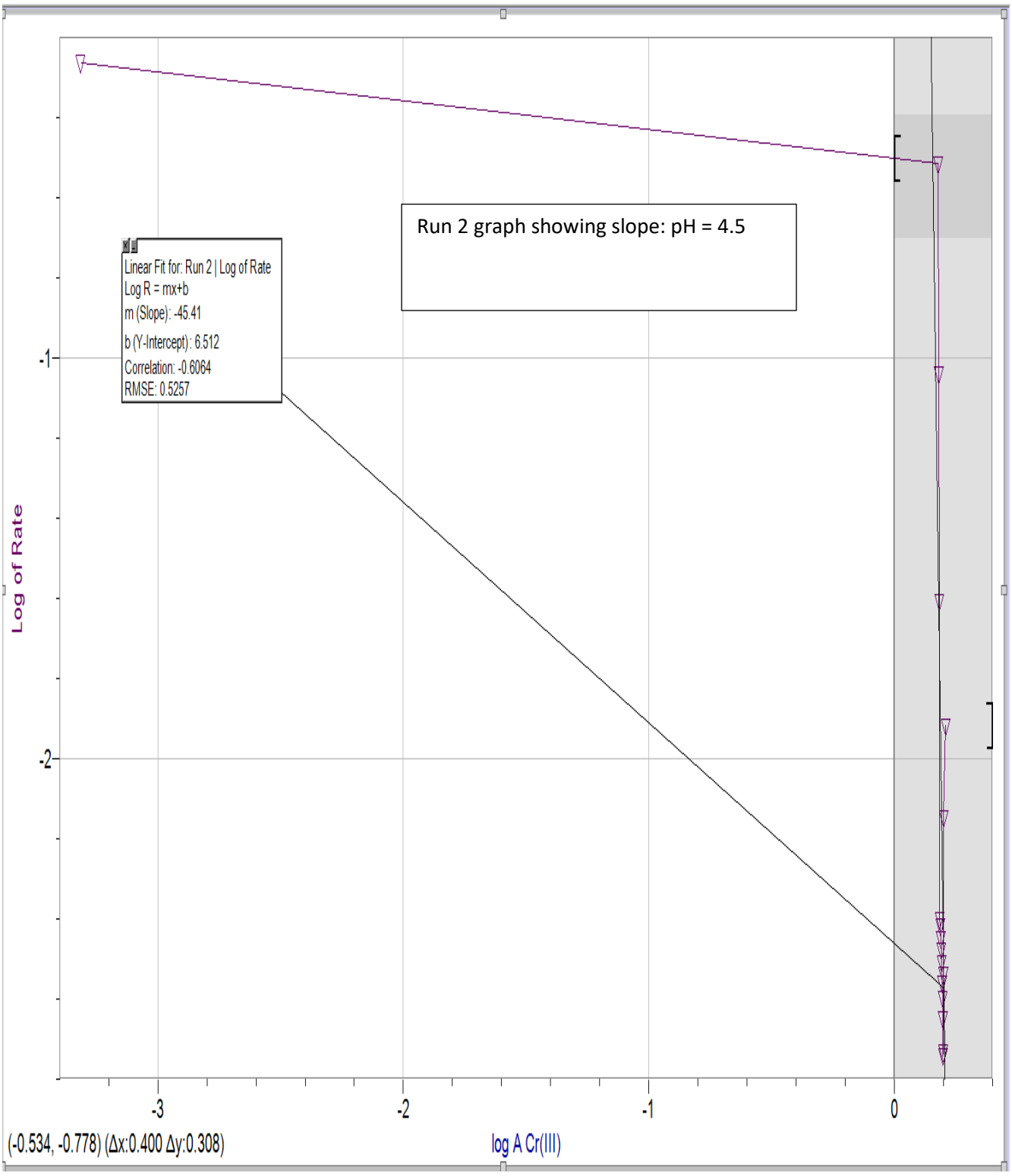

Run 2 graph: pH = 4.5
0
-1
-2
-3
log A Cr(III)
0
10
20
30
Time (min)

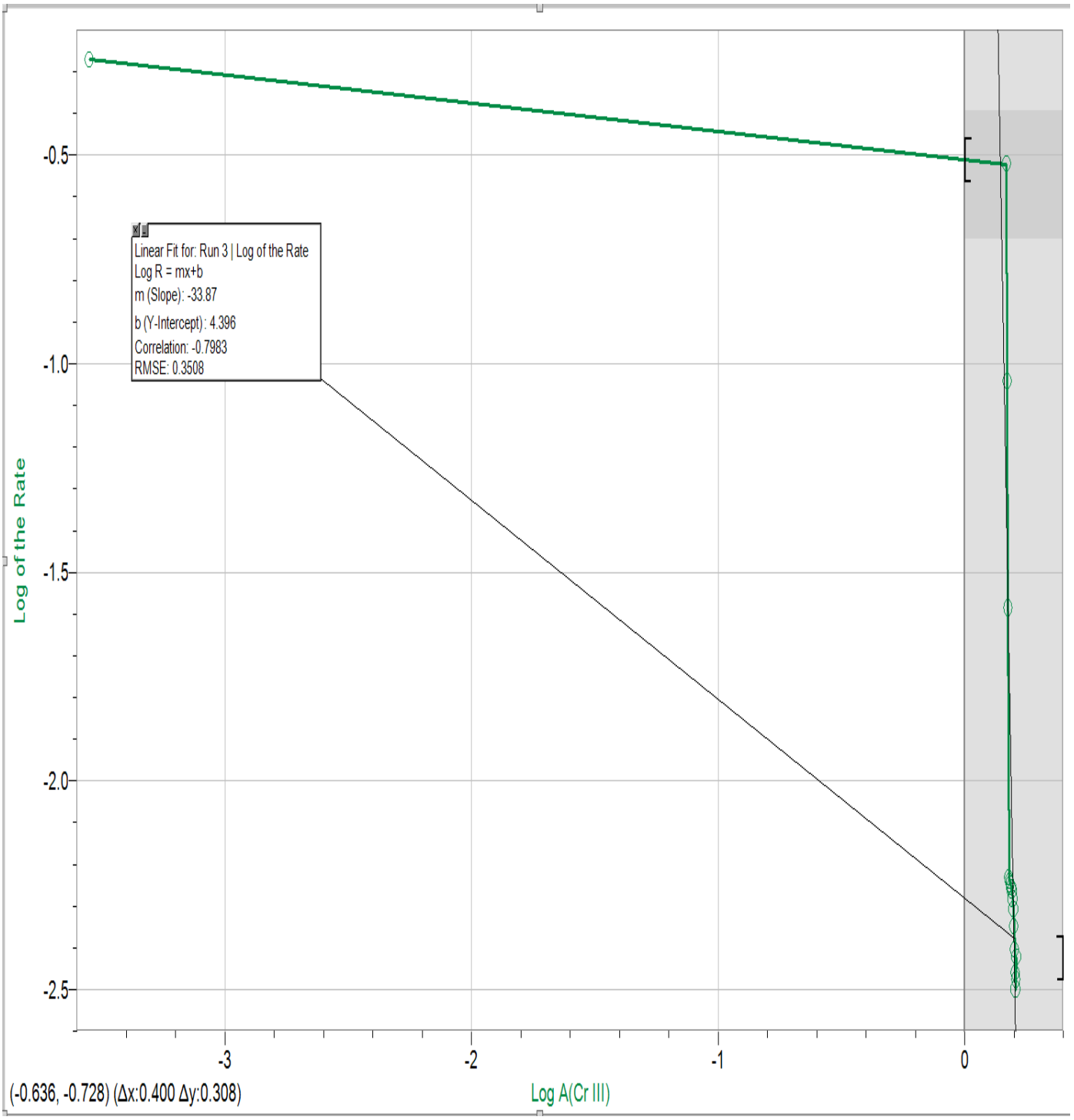

Run 3 graph: pH = 5.0
0
-1
-2
-3
Log A(Cr III)
0
10
20
30
Time (min)

Plots of log of the rate as the function of the log of ACr (III) indicating the Instantaneous Rate of Change (slope)



Run 1 graph showing slope: pH = 4.0


Run 2 graph showing slope: pH = 4.5
Linear Fit for: Run 2 | Log of Rate
Log R = mx+b
m (Slope): -45.41
b (Y-Intercept): 6.512
Correlation: -0.6064
RMSE: 0.5257
Log of Rate
-1
-2
-3
-2
-1
0
log A Cr(III)
(-0.534, -0.778) (Δx:0.400 Δy:0.308)


Linear Fit for: Run 3 | Log of the Rate
Log R = mx+b
m (Slope): -33.87
b (Y-Intercept): 4.396
Correlation: -0.7983
RMSE: 0.3508
-0.5
-1.0
-1.5
-2.0
-2.5
-3
-2
-1
0
Log of the Rate
Log A(Cr III)
(-0.636, -0.728) (Δx:0.400 Δy:0.308)

Discussion:

Temperature in this experiment gives the reactants enough energy (activation energy) needed for the reaction to occur. This increases the rate of reaction since the actual length of the experiment would vary from 4 to 6 hours at room temperature. The volume can dilute the solution, therefore maintaining a constant volume helps to determine the rate of reaction of individual species without any interference. My data felt to be reproducible because the data was obtained with the same procedures. This is important because the slight change of data obtained following the same procedures can indicate for example in medical fields the change of diseases due to some factors. The instantaneous rate of change is obtained be determining the slope of a tangent line, which is the derivative of the rate of the chromium ion. The final plots were not included in the data tables and on the graphs because they indicate an infinite time which is not on the graph itself. The partial order with respect to the hydrogen ion can be predicted by maintaining the pH of a buffer solution, thus the concentration of the hydrogen ion will remain constant. The concentration of the EDTA solution remained constant and its particular represents the concentration of the hydrogen ion. Historically, people used to plot the natural logarithm of the concentration as the function of time to simplify mathematical calculations using graphs since they had no calculators and advanced scientific technologies to simplify the work. The function of

Conclusion:

The concentration of chromium ion (Cr III) decreases as over a period of time. The values of the rate of the reaction are not the same. The rate of the reaction is determined by finding the slope (m) of the tangent line which is the derivative.

Raw data and citation on the next page

Citation:

Shoemaker, David P, "Experiments in Physical Chemistry", Chapter IX, McGraw-Hill Publishing Company, (1989)

Dr. R. Venkateswaran, ""IF IT WERE DONE...THEN 'TWERE WELL IT WERE DONE QUICKLY", General chemistry Laboratory manual, 2016, Experiment 4