CHM1311 C

Lab 3: Acid-Base Titration Lab

Bisma Rehman

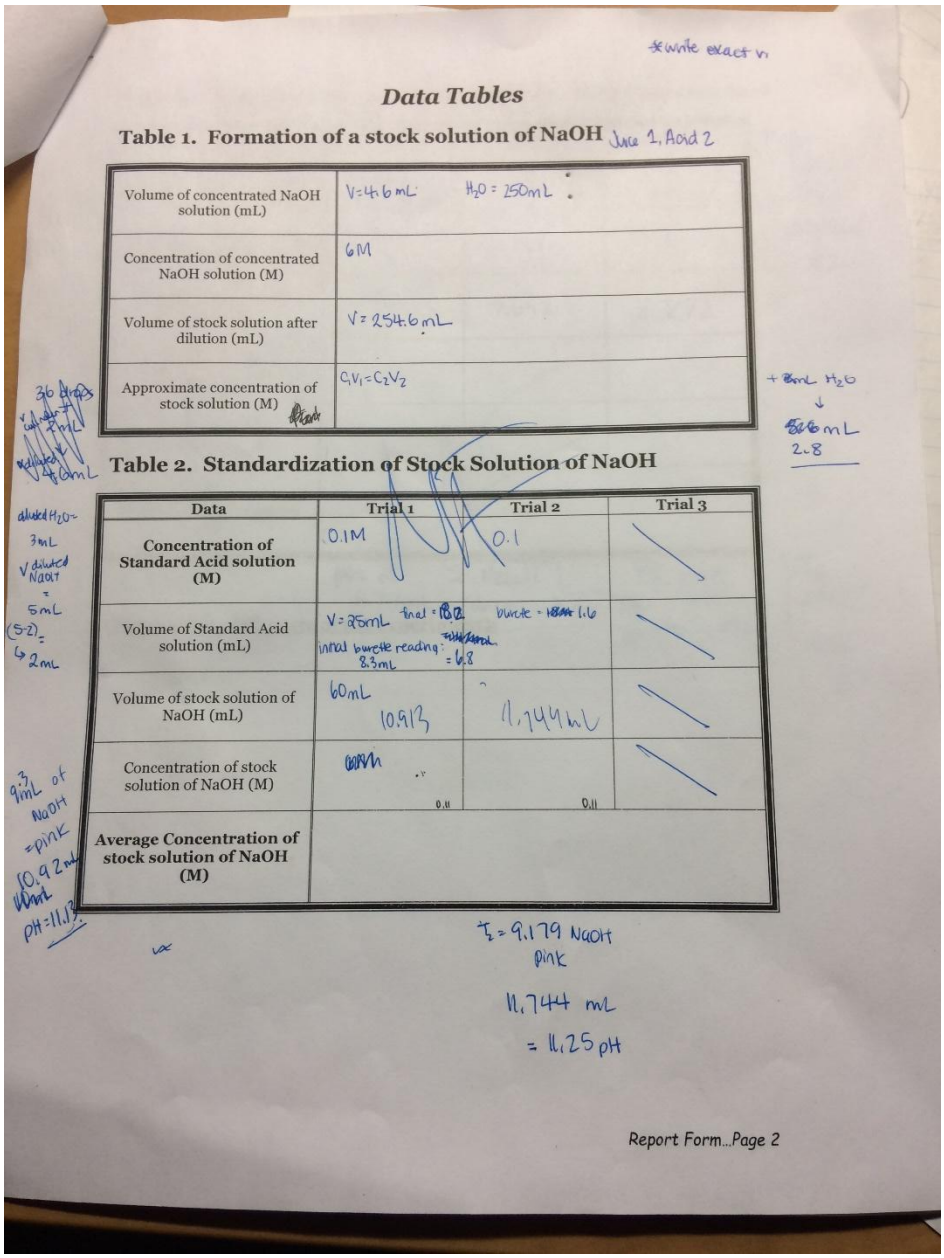
Lab Due: Thursday, October 13, 2016

Report Date: Thursday, October 20, 2016

TA: Michael Forsberg

Lab Partner: Shian Ming Chen 8597618

Raw data:



*write exact v.

Data Tables

Table 1. Formation of a stock solution of NaOH June 1, Acid 2

Volume of concentrated NaOH solution (mL)	V=4.6 mL H_2O = 250mL
Concentration of concentrated NaOH solution (M)	6M
Volume of stock solution after dilution (mL)	V = 254.6 mL
Approximate concentration of stock solution (M)	$C_1V_1 = C_2V_2$

+ 8mL H_2O → 6 mL 2.8

Table 2. Standardization of Stock Solution of NaOH

Data	Trial 1	Trial 2	Trial 3
Concentration of Standard Acid solution (M)	0.1M	0.1	
Volume of Standard Acid solution (mL)	V = 25mL final = 8.2 burette = 1.6 initial burette reading: 8.3mL = 6.8		
Volume of stock solution of NaOH (mL)	60mL 10.913	11.744mL	
Concentration of stock solution of NaOH (M)	0.11	0.11	
Average Concentration of stock solution of NaOH (M)			

36 drops 2mL 4.6mL

diluted H_2O = 3mL

V diluted NaOH = 5mL

(5-2) = 2mL

9.3mL of NaOH = pink

10.92mL

pH = 11.1?

T_2 = 9.179 NaOH pink

11.744 mL = 11.25 pH

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Table 3. Determination of the Concentration of an Unknown Acid

Run 3

Data	Trial 1	Trial 2	Trial 3
Sample Number of Unknown Acid	2	2	2
Volume of Unknown Acid solution (mL)	10.1 mL	10.1 - 20.2 10.1	10.2
Volume of stock solution of NaOH (mL)	21.026	7.692	8.872
Concentration of stock solution of NaOH (M)			
Concentration of Unknown Acid Solution (M)			
Average Concentration of Unknown Acid solution (M)			

* was supposed to plateau x2

pink @ 4.718 mL

21.026 mL *does not go ↑ than 11.73

T2 pink @ 4.821 mL

pH 11.55 = 7.692

T3 pink @ 4.923 mL

8.872

pH = 11.06

Observations (all parts of the experiment):

Table 4. Determination of the Mass Percentage of Acid in a Juice

Data	Trial 1	Trial 2	Trial 3
Sample Number of Juice	1	1	1
Volume of Juice (mL)	0.2 mL		
Volume of stock solution of NaOH (mL)	10.0mL	9.8 ~ 19.9 / 10	
Concentration of stock solution of NaOH (M)	4.128	9.590	
Concentration of acid in Juice (M)			
Average Concentration of Acid in Juice (M)			
Density of Juice (g/mL)	1.0003 g/cm^3		
Molar Mass of acid in Juice (g/mol)			
Mass Percent of Acid in Juice (%)			

$H_3C_6H_5O_7$

T1 pink 7.287 PH ~~9.128~~ 9.128

T2 = 7.744mL pink. PH=11.01 9.590

GRAPHS: Attach Logger Pro data tables AND graphs (at least 12 [2 per trial]) to this form!!

Introduction:

The lab performed was an acid-base titration. This lab consists of an acid, and a base. An acid is a proton donor, whereas a base is a proton acceptor. When an acid and base are mixed together a conjugate acid and base form. This also neutralizes one another which is when a salt and water are produced. This can be condensed into the Arrhenius definition.

Instead of having acids and bases that are identical there are weak acids, and bases, as well as strong acids and bases. An example of a strong acid is HCl which completely dissociates in water. A strong base can be NaOH where the strong base dissociates in water and results in a formation of hydroxide ions. Both weak acids and bases do not completely dissociate in water, as well as some strong bases.

The electronegativity and structure of a compound is a factor as to whether the compound will disassociate completely, this will also help determine whether the compound is a strong or weak acid or base.

This lab contains four components, two of which give protons away and another two accept protons. Again, these are called conjugate acid-base pairs.

As previously stated, when acids and bases react they neutralize the compound and form salt and water. This is exactly what a titration is. A titration is when the concentration of an acid and base is neutralized. This produces a pink solution because of the phenolphthalein that is added to the solution.

This also helps us find the equivalence point, where we observe the pH curve and we conclude based off the highest slope in the titration curve what this value is.

The equations used in this lab are:

$$C_1V_1=C_2V_2$$

- to find the concentration after the titration

$$C_{base}=(b/a)\ ((C_{acid} \times V_{acid})/V_{base})$$

- to find the concentration of the base

$$\text{Mass \% acid in juice} = ((\text{Cacid} \times M_{acid})/ (\text{density juice}) \times 1000)\ (100)$$

Procedure:

As described in the lab manual.

Data Tables:

Table 1. Formation of a Stock Solution of NaOH

Volume of concentrated NaOH solution (mL)	4.6 mL
Concentration of concentrated NaOH (M)	6 M
Volume of stock solution after dilution (mL)	254.6
Concentration of stock solution (M)	0.1084 =0.11

Table 2. Standardization of Stock Solution of NaOH

Data	Trial 1	Trial 2
Concentration of Standard Acid Solution (M)	0.1	0.1
Volume of Standard Acid Solution (mL)	Initial= 16.7 Final= 6.8 Final – Initial= 9.9 mL	Initial= 1.6 mL Final = 11.6 mL Final – Initial= 10 mL
Volume of Stock Solution of NaOH (mL)	19.20	20.23
Concentration of Stock Solution of NaOH (M)	0.052	0.054
Average Concentration of Stock Solution of NaOH (M)	0.053	0.053

Observations: The solution slowly ended up turning pink, and got a richer pink as more of the solution was made. The pH of the solution first slowly rose, and then rapidly rose.

Table 3. Determination of the Concentration of an Unknown Acid

Data	**Trial 1**	Trial 2	Trial 3
Sample Number of Unknown Acid	**2**	2	2
Volume of Unknown Acid (mL)	**10.1**	Final – Initial= = 20.2- 10.1 =10.1	10.2
Volume of Stock Solution of NaOH (mL)	**33.45**	19.22	25.19
Concentration of Stock Solution of NaOH (M)	**0.01**	0.05	0.05
Concentration of Unknown Acid Solution (M)	0.09	0.05	0.07
Average Concentration of Unknown Acid Solution	0.07	0.07	0.07

Observation: The solution that was formed became pink and then disappeared at the equivalence point. The more concentrated the solution became the darker the pink became. The plateau was supposed to occur twice.

Table 4. Determination of the Mass Percentage of Acid in a Juice

Data	Trial 1	Trial 2
Sample Number of Juice	1	1
Volume of Juice (L)	0.2	0.2
Volume of Stock Solution of NaOH (mL)	10.0	10.0
Concentration of Stock Solution of NaOH (M)	4.128	9.590
Concentration of Acid in Juice (M)	0.05	0.04
Average Concentration of Acid in Juice (M)	0.06	0.07
Density of Juice (g/mL)	1.0003	1.0003
Molar Mass of acid in Juice (g/mol)	192.21	192.21
Mass Percent of Acid in Juice (%)	0.90	0.90

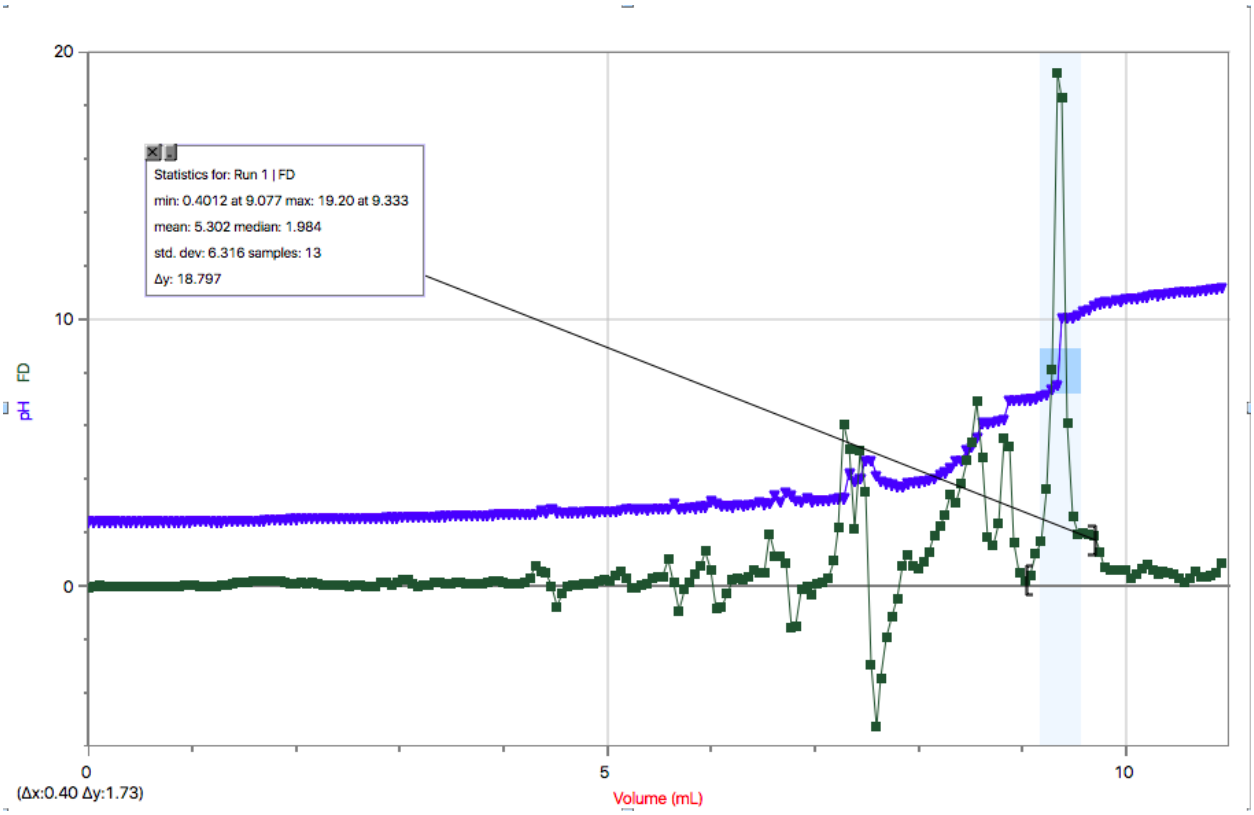
Observation: Solution became a slight pink to dark pink, took a longer period of time to reach a pH of 11.

Graphs and Tables (Logger Pro)

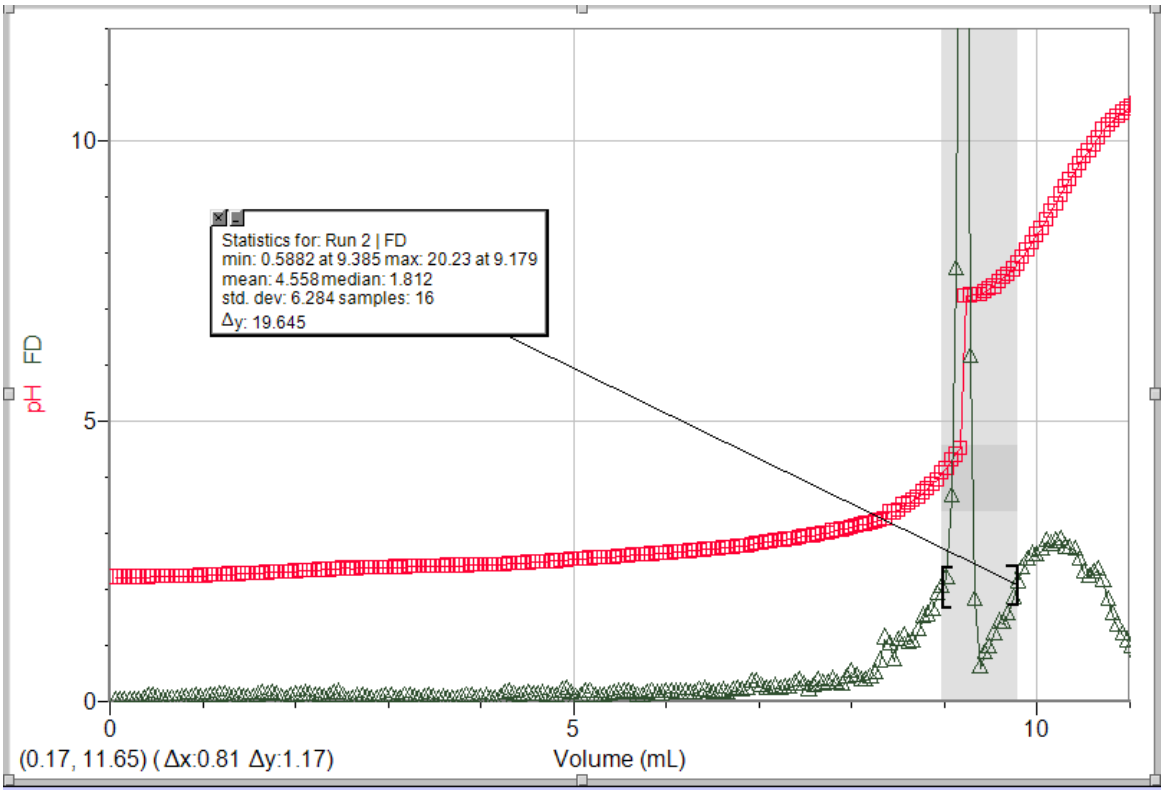
Partial Representation of Data Chart

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6		Run 7		
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	V
1	0.000	2.43	0.000		0.000	2.56	0.000	2.56	0.000	2.58	0.000	3.19	0.000	3.11	
2	0.051	2.43	0.051	2.22	0.051	2.57	0.051	2.56	0.051	2.58	0.051	3.19	0.051	3.11	
3	0.103	2.43	0.103	2.22	0.103	2.56	0.103	2.56	0.103	2.58	0.103	3.18	0.103	3.11	
4	0.154	2.43	0.154	2.22	0.154	2.56	0.154	2.56	0.154	2.58	0.154	3.19	0.154	3.11	
5	0.205	2.43	0.205	2.22	0.205	2.56	0.205	2.56	0.205	2.58	0.205	3.19	0.205	3.11	
6	0.256	2.43	0.256	2.22	0.256	2.56	0.256	2.56	0.256	2.58	0.256	3.20	0.256	3.11	
7	0.308	2.43	0.308	2.22	0.308	2.56	0.308	2.59	0.308	2.59	0.308	3.22	0.308	3.11	
8	0.359	2.43	0.359	2.22	0.359	2.55	0.359	2.59	0.359	2.59	0.359	3.23	0.359	3.11	
9	0.410	2.43	0.410	2.22	0.410	2.55	0.410	2.59	0.410	2.59	0.410	3.23	0.410	3.13	
10	0.462	2.43	0.462	2.22	0.462	2.55	0.462	2.59	0.462	2.59	0.462	3.24	0.462	3.13	
11	0.513	2.43	0.513	2.22	0.513	2.55	0.513	2.59	0.513	2.60	0.513	3.25	0.513	3.13	
12	0.564	2.43	0.564	2.23	0.564	2.55	0.564	2.59	0.564	2.61	0.564	3.26	0.564	3.14	
13	0.615	2.43	0.615	2.22	0.615	2.55	0.615	2.60	0.615	2.61	0.615	3.27	0.615	3.15	
14	0.667	2.43	0.667	2.23	0.667	2.56	0.667	2.59	0.667	2.61	0.667	3.27	0.667	3.17	
15	0.718	2.43	0.718	2.23	0.718	2.55	0.718	2.60	0.718	2.61	0.718	3.28	0.718	3.19	
16	0.769	2.43	0.769	2.23	0.769	2.56	0.769	2.60	0.769	2.61	0.769	3.31	0.769	3.22	
17	0.821	2.43	0.821	2.23	0.821	2.56	0.821	2.61	0.821	2.61	0.821	3.33	0.821	3.25	
18	0.872	2.43	0.872	2.23	0.872	2.57	0.872	2.61	0.872	2.62	0.872	3.35	0.872	3.28	
19	0.923	2.43	0.923	2.24	0.923	2.58	0.923	2.61	0.923	2.62	0.923	3.37	0.923	3.29	
20	0.974	2.43	0.974	2.24	0.974	2.59	0.974	2.61	0.974	2.62	0.974	3.39	0.974	3.31	
21	1.026	2.43	1.026	2.24	1.026	2.61	1.026	2.61	1.026	2.62	1.026	3.39	1.026	3.35	
22	1.077	2.43	1.077	2.25	1.077	2.63	1.077	2.62	1.077	2.63	1.077	3.40	1.077	3.37	
23	1.128	2.43	1.128	2.25	1.128	2.64	1.128	2.62	1.128	2.63	1.128	3.41	1.128	3.40	
24	1.179	2.43	1.179	2.25	1.179	2.64	1.179	2.62	1.179	2.63	1.179	3.45	1.179	3.41	
25	1.231	2.43	1.231	2.26	1.231	2.65	1.231	2.62	1.231	2.64	1.231	3.53	1.231	3.43	
26	1.282	2.43	1.282	2.27	1.282	2.65	1.282	2.63	1.282	2.64	1.282	3.57	1.282	3.45	
27	1.333	2.43	1.333	2.27	1.333	2.65	1.333	2.64	1.333	2.64	1.333	3.59	1.333	3.48	
28	1.385	2.43	1.385	2.27	1.385	2.65	1.385	2.64	1.385	2.65	1.385	3.60	1.385	3.50	

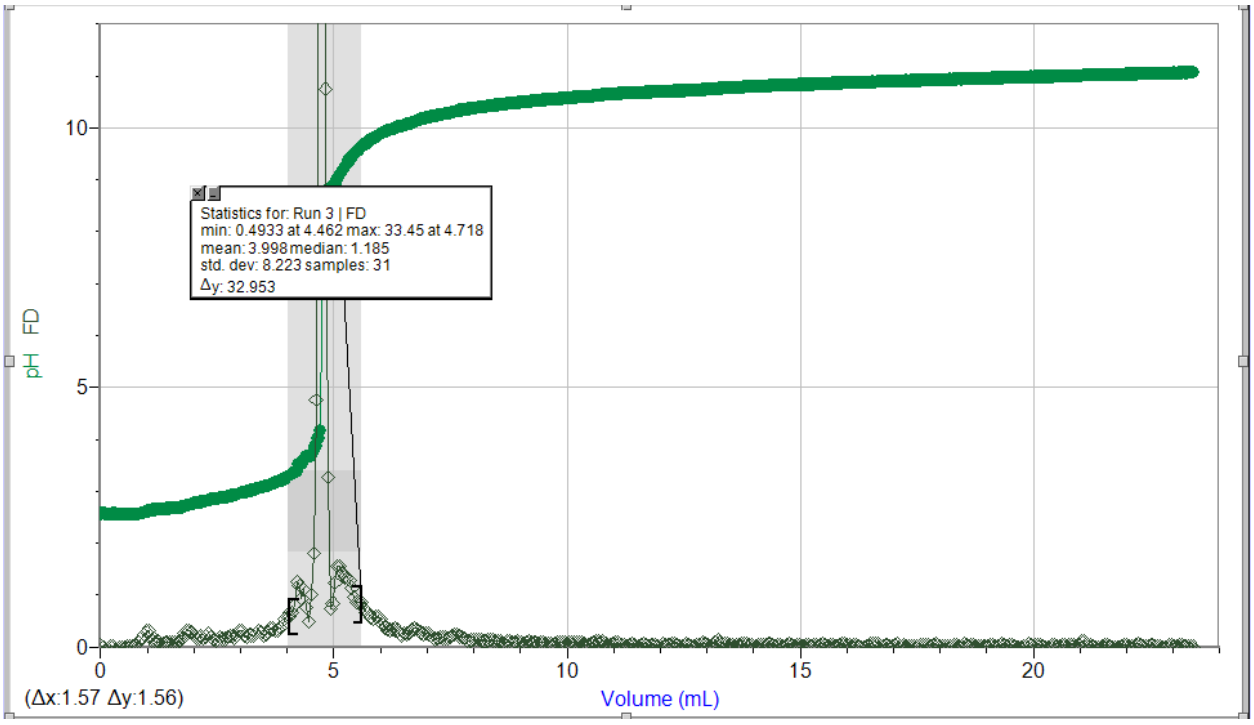
Partial plot of pH as a function of volume for the standardization of NaOH with the first derivative for Trial 1



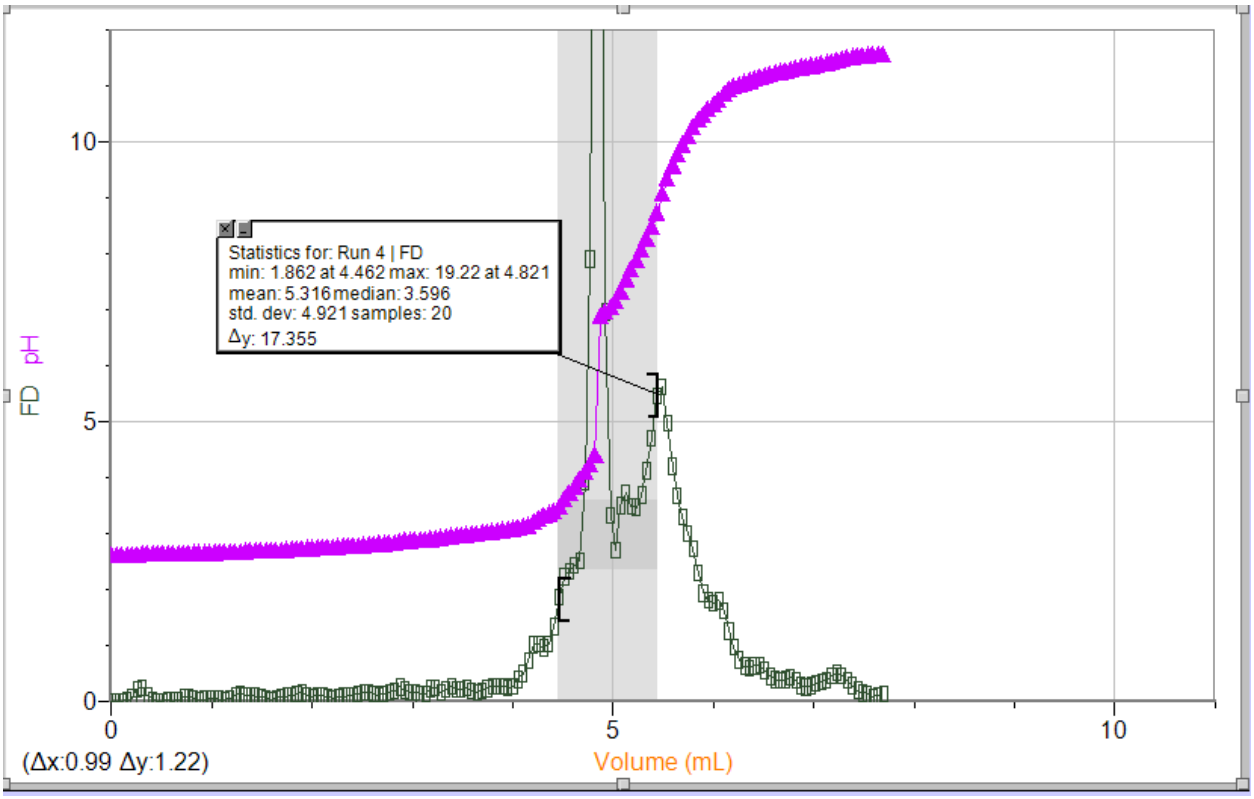
pH as a function of volume for the standardization of NaOH and the first derivative for Trial 2



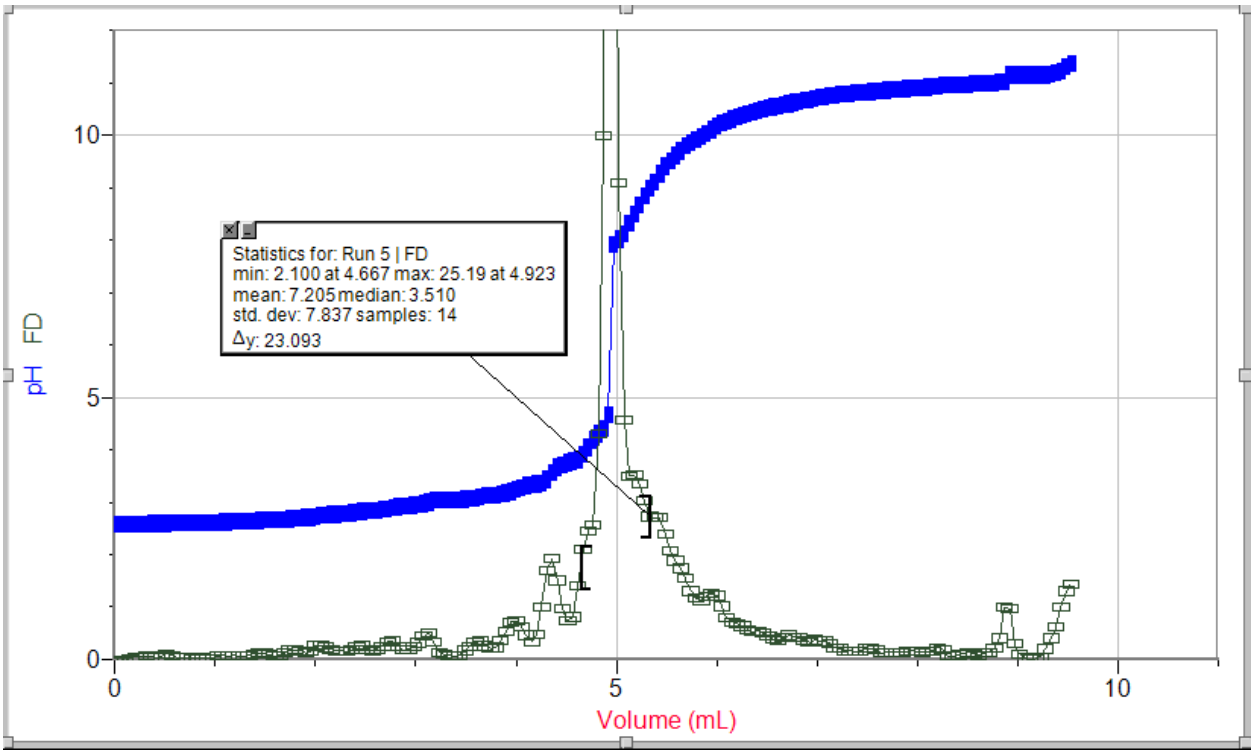
Partial plot pH as a function of volume for the standardization of NaOH and first derivative for Trial 3



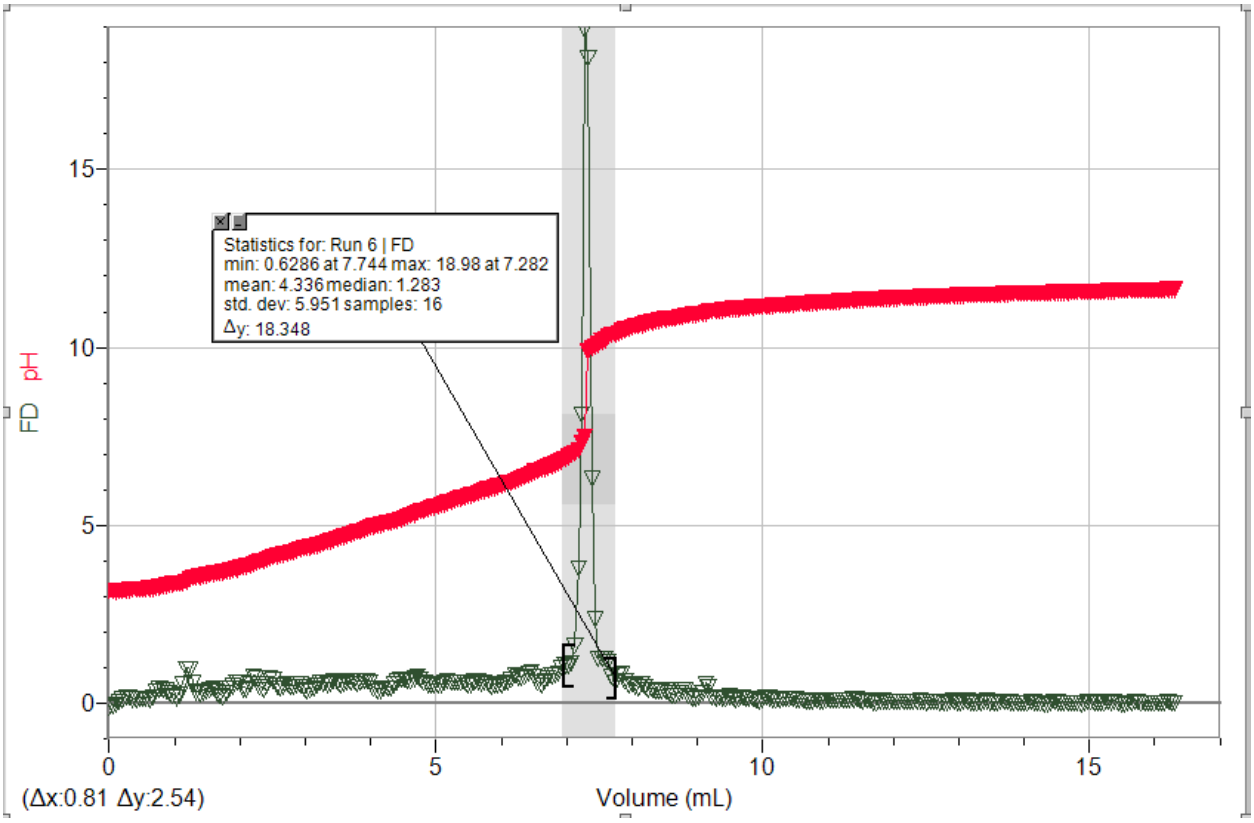
Partial plot of pH as a function of volume for the standardization of NaOH and first derivative for Trial 4



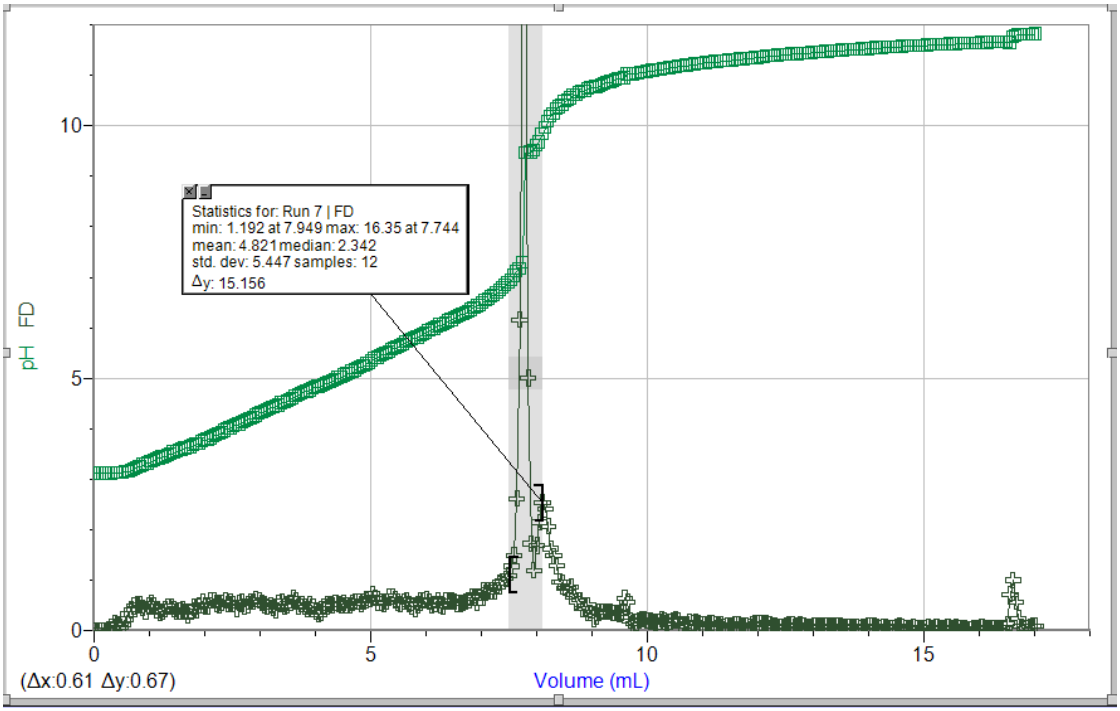
Partial plot of pH as a function of volume for the standardization of NaOH and the first derivative for Trial 5



Partial plot of pH as a function of volume for the standardization of NaOH and the first derivative for Trial 6



Partial plot of pH as a function of volume for the standardization of NaOH and the first derivative for Trial 7



Calculations:

Sample Calculation (Part 1)

1. Approx. concentration of stock solution
   $C_2=(C_1V_1)/V_2$
   =(0.0046)/ (0.2546)
   =0.10841 M **=0.11 M**

Sample Calculation (Part 2)

1. Exact concentration of stock solution (from visual endpoint and cV calculations AND by first derivative from titration curve using LabQuest 2 data):

TRIAL 1

$n_{base}= (C_{base})(V_{base})$

= (0.1084) (0.02023)

$=2.19 \times 10^{-3}$ mol

$n_{acid} = 0.5n_{base}$

$=1.09 \times 10^{-3}$ mol

$V^{acid} = n_{acid}/C_{acid}$

$= 1.09645 \times 10^{-3} / 0.10$

$= 1.01$ M

$C_{base}Vb_{ase} = C_{acid}V_{acid}$

$C_{base} = (0.1)(0.01096466)/0.02023$

=0.05 M

2. Average concentration of stock solution

Average concentration= $(C_{trial\ 1} + C_{trial\ 2})/2 = 0.054 + 0.052 = 0.053$ M

Sample Calculation (Part 3)

1. Concentration of Unknown Acid (from visual endpoint and cV calculations AND by first derivative from titration curve using LabQuest data):

TRIAL 1

$n_{base} = (0.053)(0.03345)$

$= 1.77 \times 10^{-3}$ mol

$n_{acid} = (0.5)(1.77 \times 10^{-3})$

$= 8.86 \times 10^{-4}$

$V_{acid} = (8.86 \times 10^{-4}) / (0.08776$ mol/L)

$= 1.01 \times 10^{-3}$ L

$C_{base} = 2C_{acid}V_{acid}/V_{base}$

$= (2(0.087765)(1.01 \times 10^{-3}))/ (0.03345)$

=0.01 M

2. Average concentration of unknown acid:

Average concentration of unknown acid= (0.08776+0.0504+0.0654)/3

=0.07 M

Sample Calculation (Part 4)

1. Concentration of acid in juice (from visual endpoint and cV calculations AND by first derivative from titration curve using LabQuest data):

$N_{base}=C_{base}V_{base}$
$= (0.053)\ (0.01898)$
$= 1.01 \times 10^{-3}$ mol

$n_{acid}= 0.5\ (1.01 \times 10^{-3})$
$= (5.0297 \times 10^{-4})$ mol

$C_{acid}= n_{acid}/V_{acid}$
$= (5.0297 \times 10^{-4})\ (0.010)$
= 0.05 M

2. Average concentration of acid in juice:

Average concentration = (0.0433275 + 0.050297) /2
= **0.047 M**

3. Mass percentage of acid in juice:

Mass Percent= ((C_{acid}) (Molar Mass Citric Acid)/(density) (1000)) (100)

=0.90%

Discussion:

The purpose of this lab was to understand the difference between titrating diprotic and triprotic solutions. The volume of the concentrated NaOH or the stock solution did not matter because any volume would still allow the concentration for the acid to be found as it was being titrated. The volume may increase or decrease but the concentration at the end will be the same.

The titration curves indicated that there is an equivalence point that occurs. When the diprotic solution was titrated there was supposed to be two point of inflections because a diprotic solution has two titratable protons. Whereas when the triprotic solution was titrated there was supposed to be three point of inflections because a triprotic solution has three titratable protons.

We did not obtain the two and three point of inflections however this is probably because the LabQuest was stopped before it could occur.

The concentration of the base allows us to find the number of moles used to neutralize the solutions.

The volumes that were observed compared to the volumes on Logger Pro were fairly similar. We were observing the pH change so the results were very close together.

There is a factor of 1000 in the equation for the mass percent of acid in the juice because the density of the juice is given in g/mL whereas the concentration of the juice is found in mol/L.

Some errors that may have occurred or that appear on the lab are that the volumes may not be as accurate as they are on the Logger Pro graphs and that the LabQuest readings were cut short so the obvious inclination in the readings may not appear.

Conclusion:

The average concentration of the stock solution of NaOH was 0.053M. The concentration of the unknown acid number 2 was 0.07M. The concentration of the acid in unknown juice number 1 was 0.047M. The mass percent of the acid was 0.90% These results are fairly accurate.

Works Cited

Dr. R. Venkateswaran, "What in the World Isn't Chemistry?", *General Chemistry Laboratory*, 2016, Experiment 3, Procedure, Pg. (2-5), Print.

Shazia Perveen, Sheikh Mohiuddin, "Multiprocity of Weak Acids: Inflection Point vs. Equivalence Point" *pubs. scipub.com,* Vol4, 2016, Introduction, Pg (1, 4), Print.