Data Tables

Table 1. Formation of a stock solution of NaOH

Volume of concentrated NaOH solution (mL)	4.05
Concentration of concentrated NaOH solution (M)	6
Volume of stock solution after dilution (mL)	254.05
Approximate concentration of stock solution (M)	0.09650

Table 2. Standardization of Stock Solution of NaOH

Data	Trial 1	Trial 2	Trial 3
Concentration of Standard Acid solution (M)	0.1	0.1	0.1
Volume of Standard Acid solution (mL)	10.05	10.00	10.00
Volume of stock solution of NaOH (mL) - Observed	10.45	11.279	11.23
Volume of stock solution of NaOH (mL) - exact	11.08	11.76	11.24
Concentration of stock solution of NaOH (M)	0.09070	0.08503	0.08718
Average Concentration of stock solution of NaOH (M)	0.086105		

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 solution (mL)	10.00	10.00	10.00
Volume of stock solution of NaOH (mL) – Observed	5.98	6.077	5.980
Volume of stock solution of NaOH (mL) - Exact	6.320	6.514	6.223
Concentration of stock solution of NaOH (M)	0.086105	0.086105	0.086105
Concentration of Unknown Acid Solution (M)	0.027209	0.02804	0.02679
Average Concentration of Unknown Acid solution (M)	0.027346		

Observations (all parts of the experiment):

All acids and the base are colourless, the indicator was also transparent. While titration, the closer that we got to the end point, the color change of each drop in the solution was more visible but because of the stirrer is still disappeared. At the end point the colour of the solution changed from transparent pink very quickly. The intensity of the colour pink ranged from light at the beginning of the change to darker pink with the addition of NaOH after the end point.

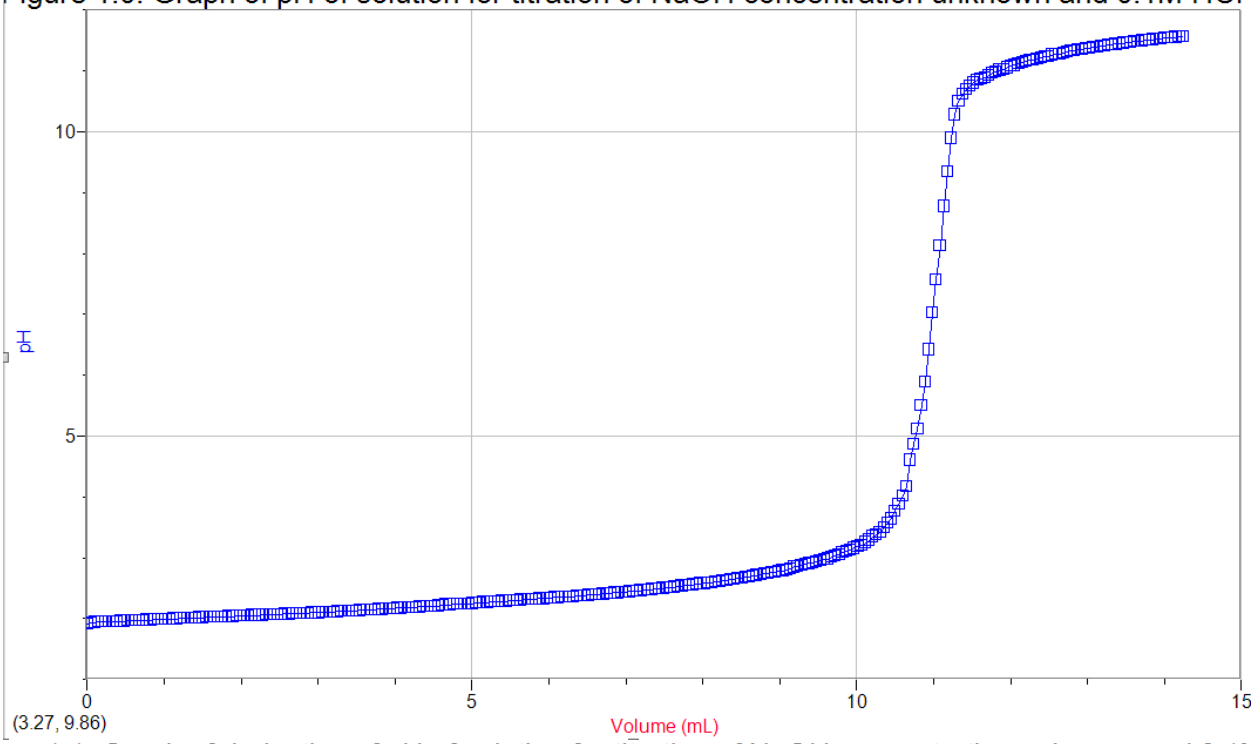
Table 4. Determination of the Mass Percentage of Acid in a Juice

Data	Trial 1	Trial 2	Trial 3
Sample Number of Juice	1	1	1
Volume of Juice (mL)	10.00	10.00	10.00
Volume of stock solution of NaOH (mL) – Observed	8.994	9.528	6.672
Volume of stock solution of NaOH (mL) - Exact	9.285	9.674	9.869
Concentration of stock solution of NaOH (M)	0.086105	0.086105	0.086105
Concentration of acid in Juice (M)	0.0266494	0.0277659	0.0283256
Average Concentration of Acid in Juice (M)	0.0280		
Density of Juice (g/mL)	0.9974		
Molar Mass of acid in Juice (g/mol)	192.123		
Mass Percent of Acid in Juice (%)	0.54%		

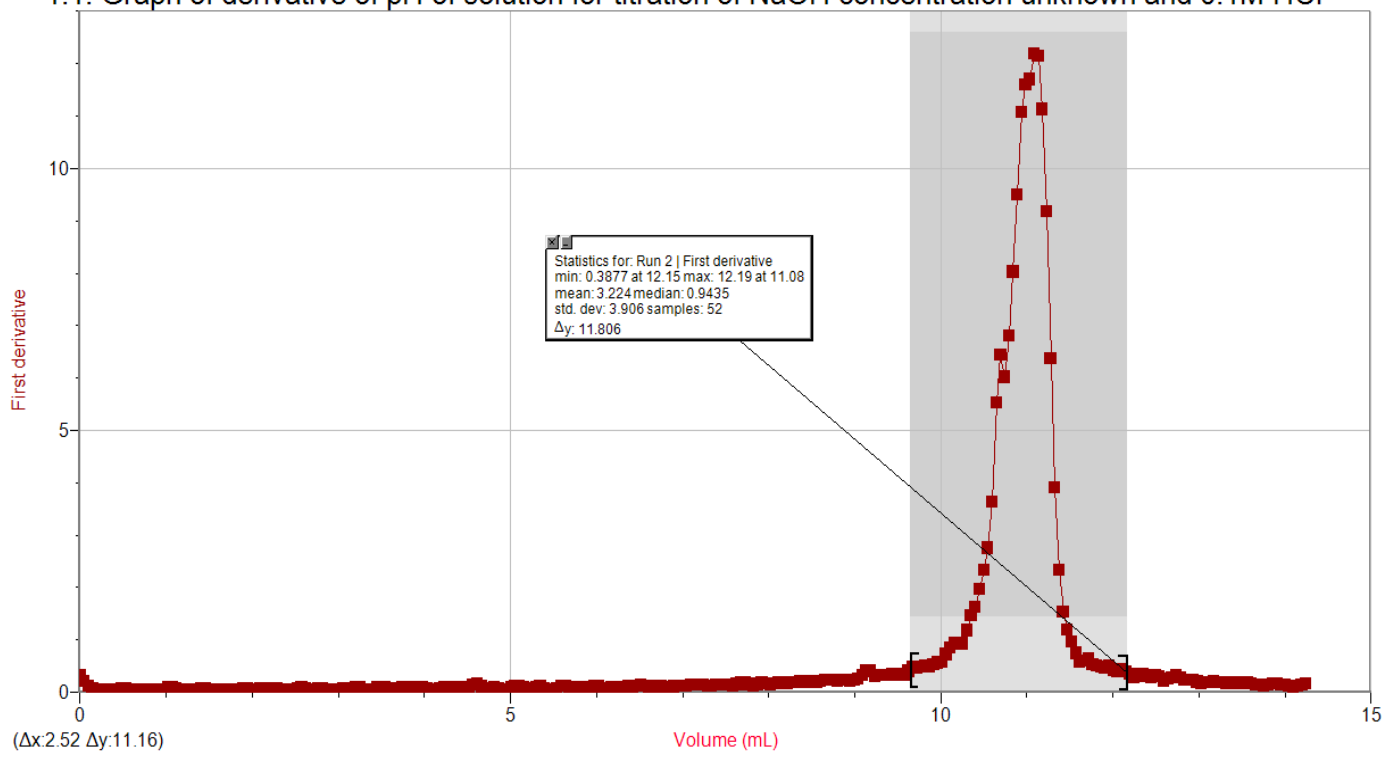
GRAPHS: Attach Logger Pro data tables AND graphs (at least 12 [2 per trial]) to this form!!

Trial 1 (run 2 in logger pro): finding the concentration of NaOH

Figure 1.0: Graph of pH of solution for titration of NaOH concentration unknown and 0.1M HCl

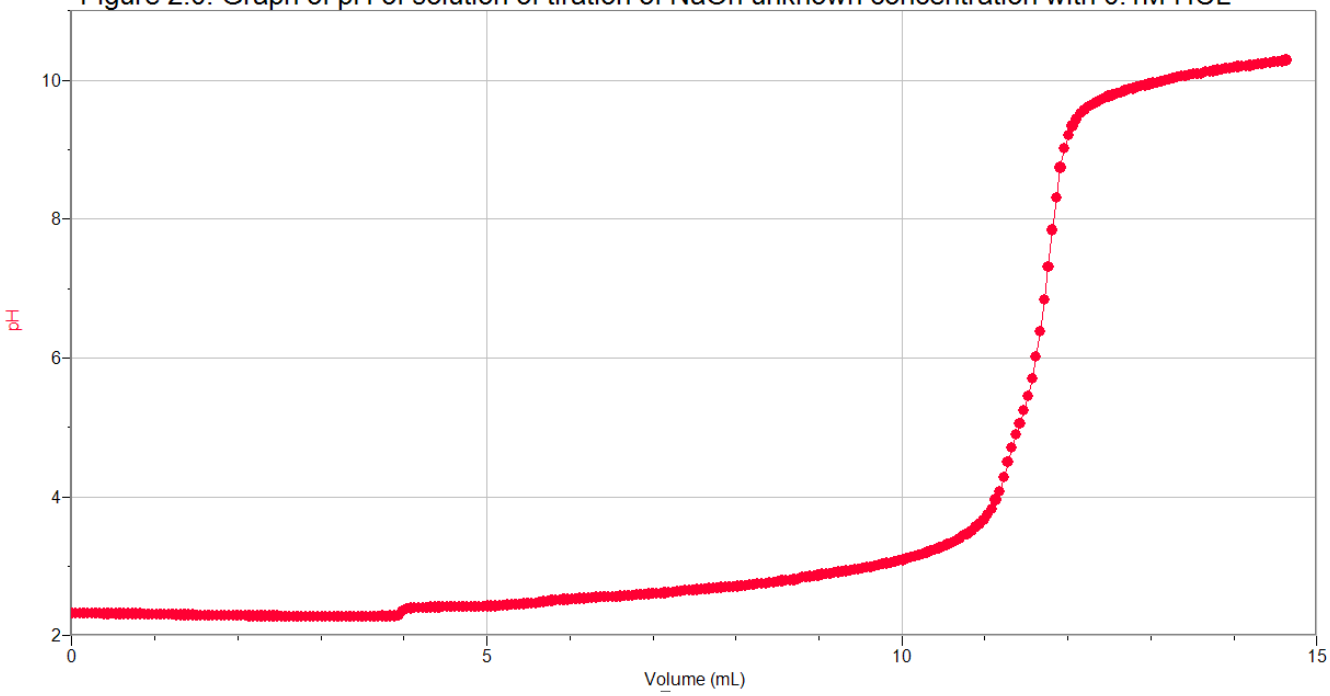


1.1: Graph of derivative of pH of solution for titration of NaOH concentration unknown and 0.1M HCl

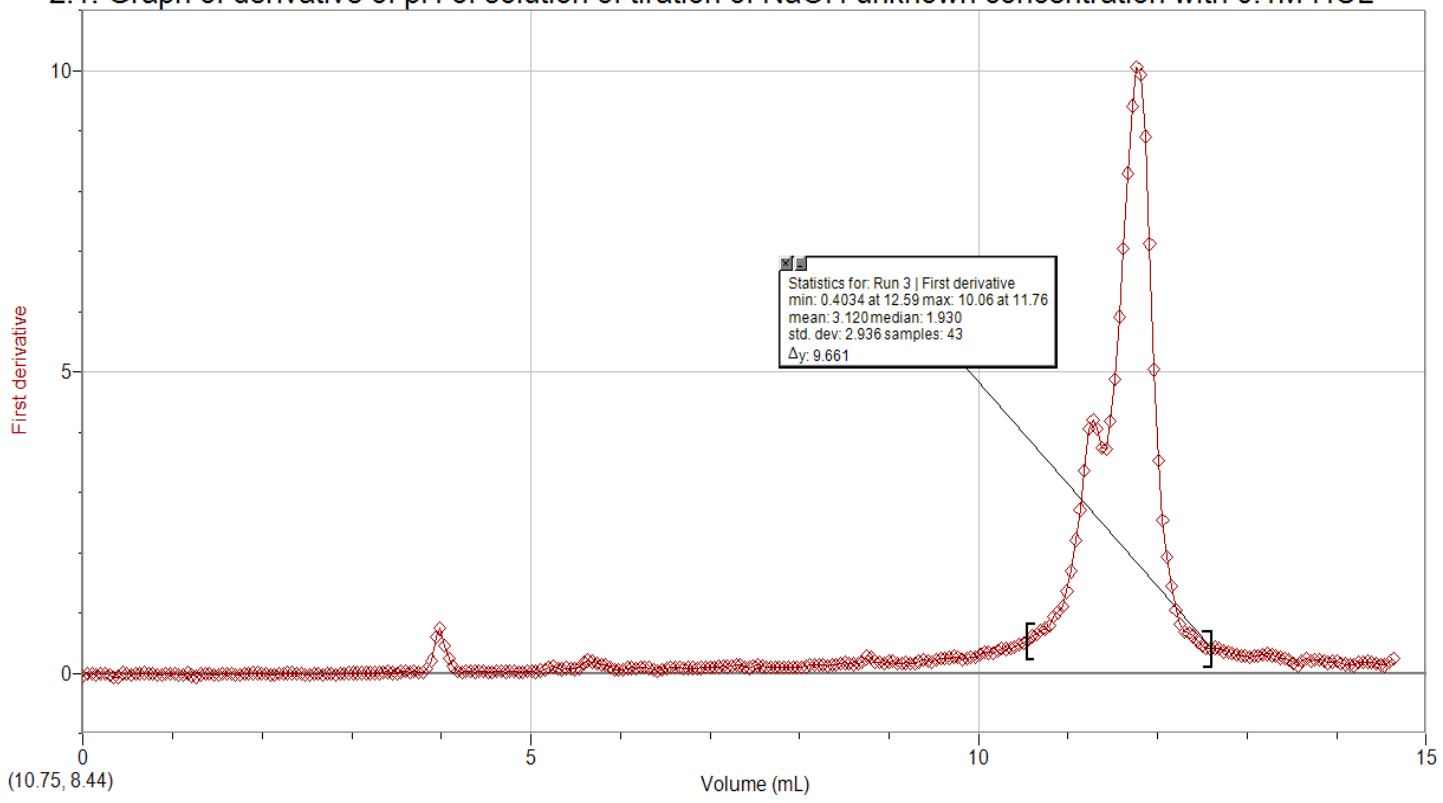


Trial 2 (run 3 in logger pro): finding the concentration of NaOH

Figure 2.0: Graph of pH of solution of tiration of NaOh unknown concentration with 0.1M HCL

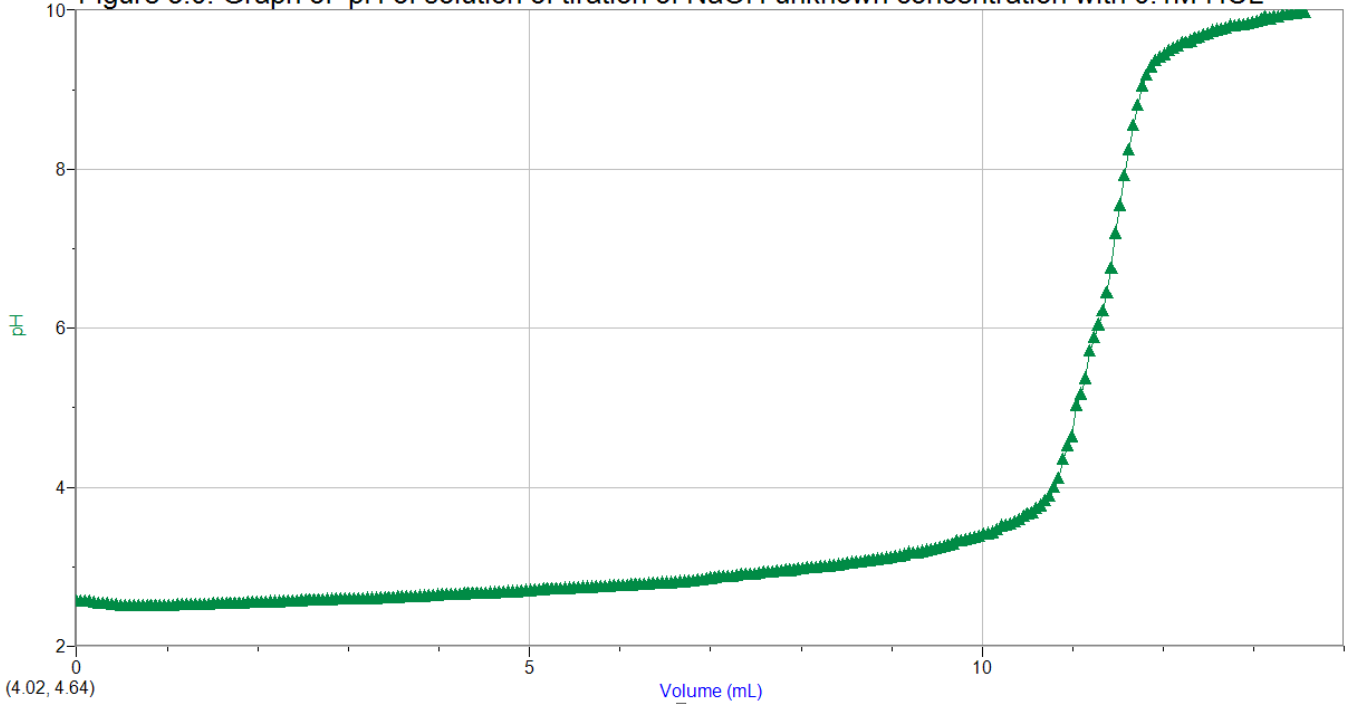


2.1: Graph of derivative of pH of solution of tiration of NaOH unknown concentration with 0.1M HCL

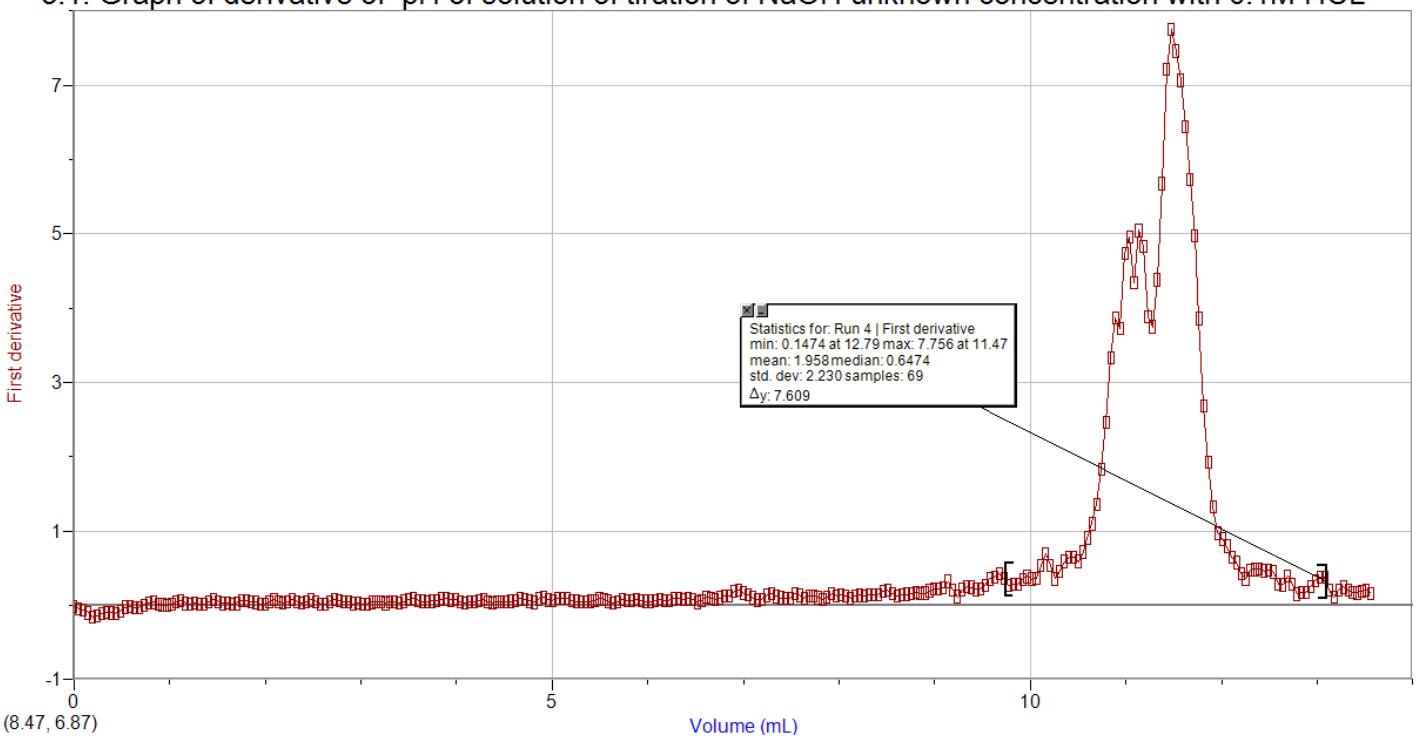


Trial 3 (run 4 in logger pro): finding the concentration of NaOH

Figure 3.0: Graph of pH of solution of tiration of NaOH unknown concentration with 0.1M HCL

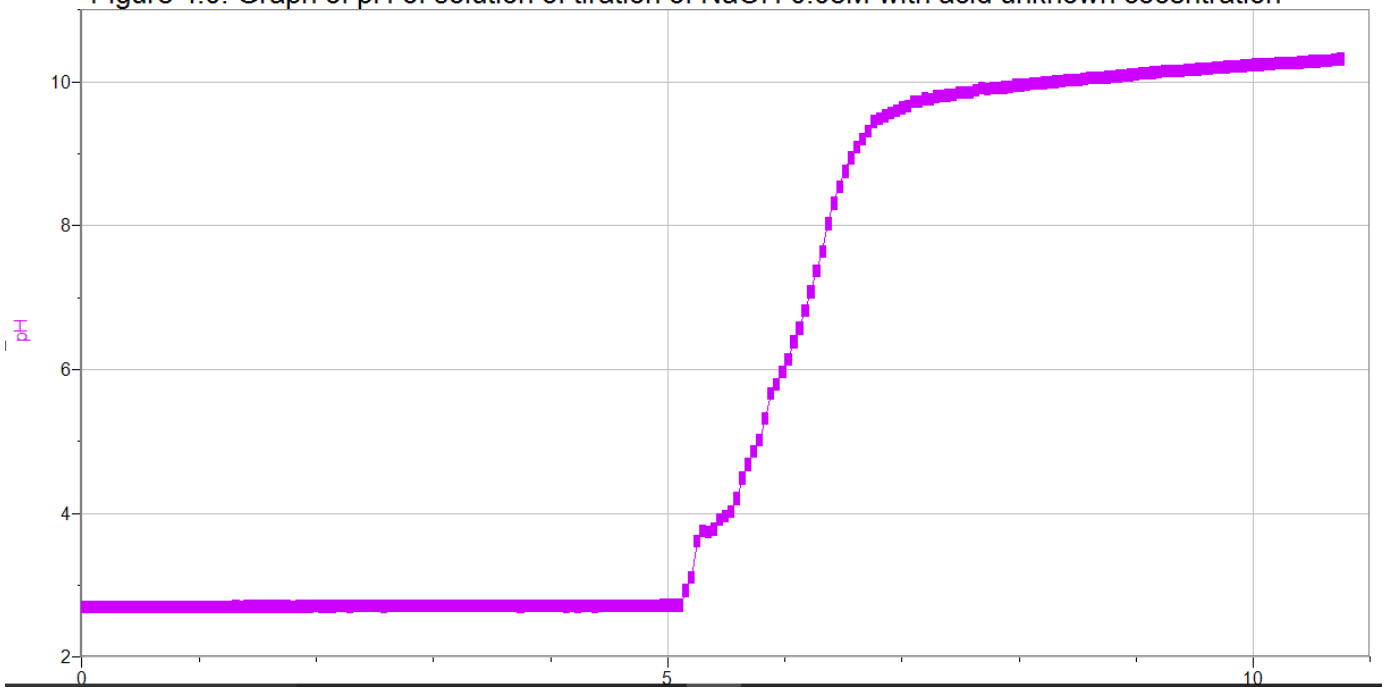


3.1: Graph of derivative of pH of solution of tiration of NaOH unknown concentration with 0.1M HCL

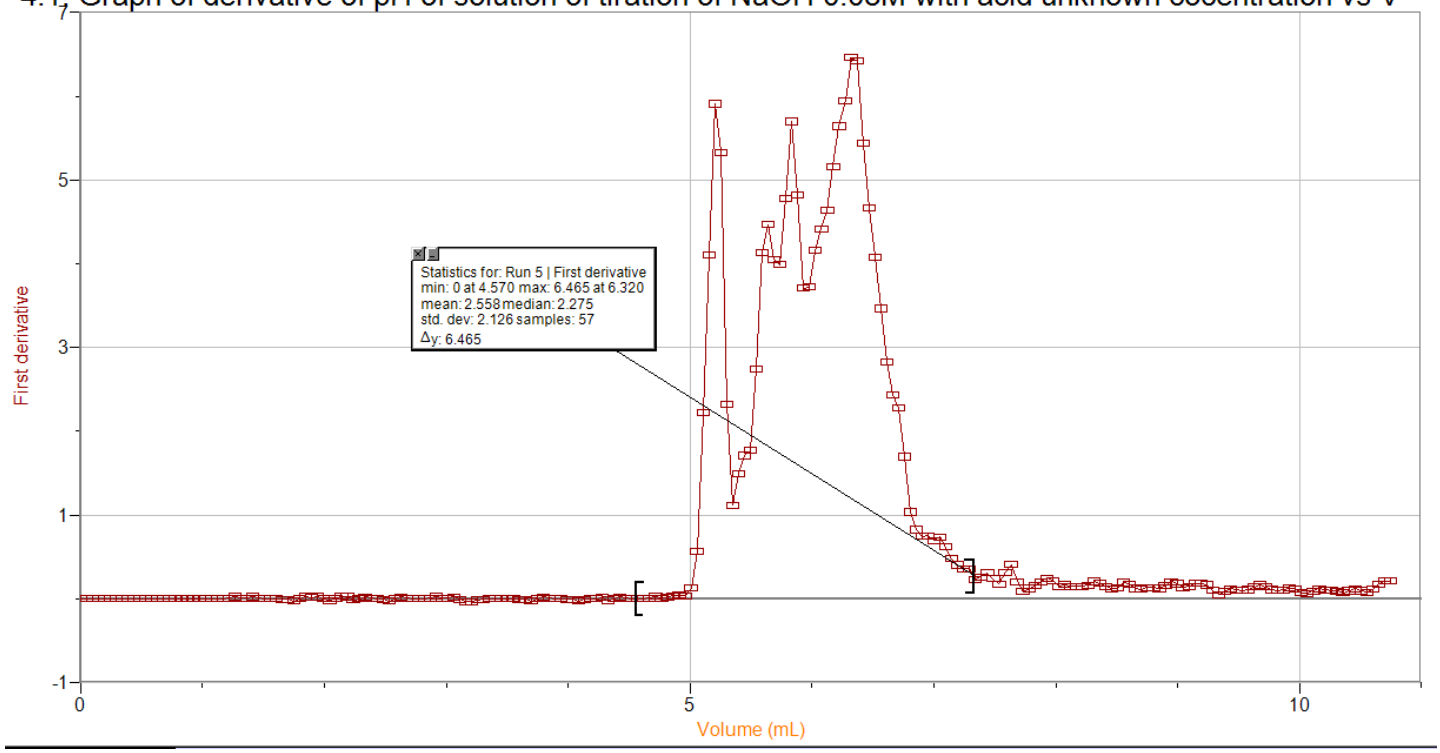


Trial 4 (run 5 in logger pro): finding the concentration of unknown acid #2

Figure 4.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration

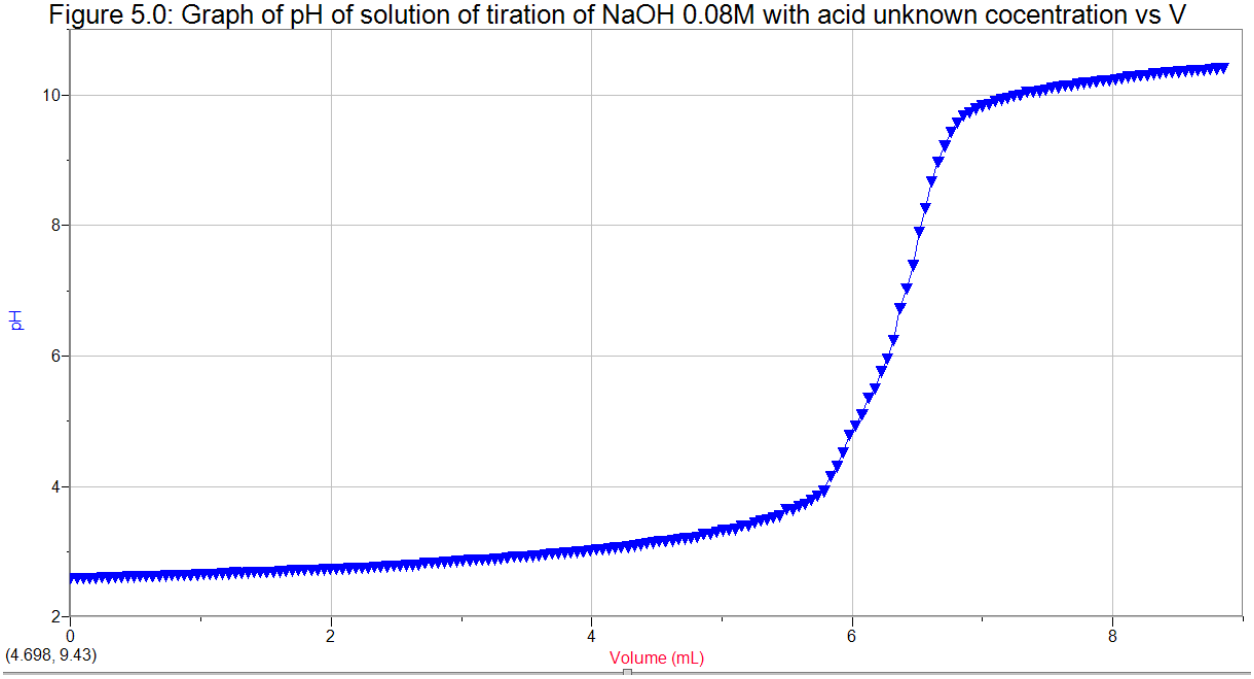


4.1; Graph of derivative of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

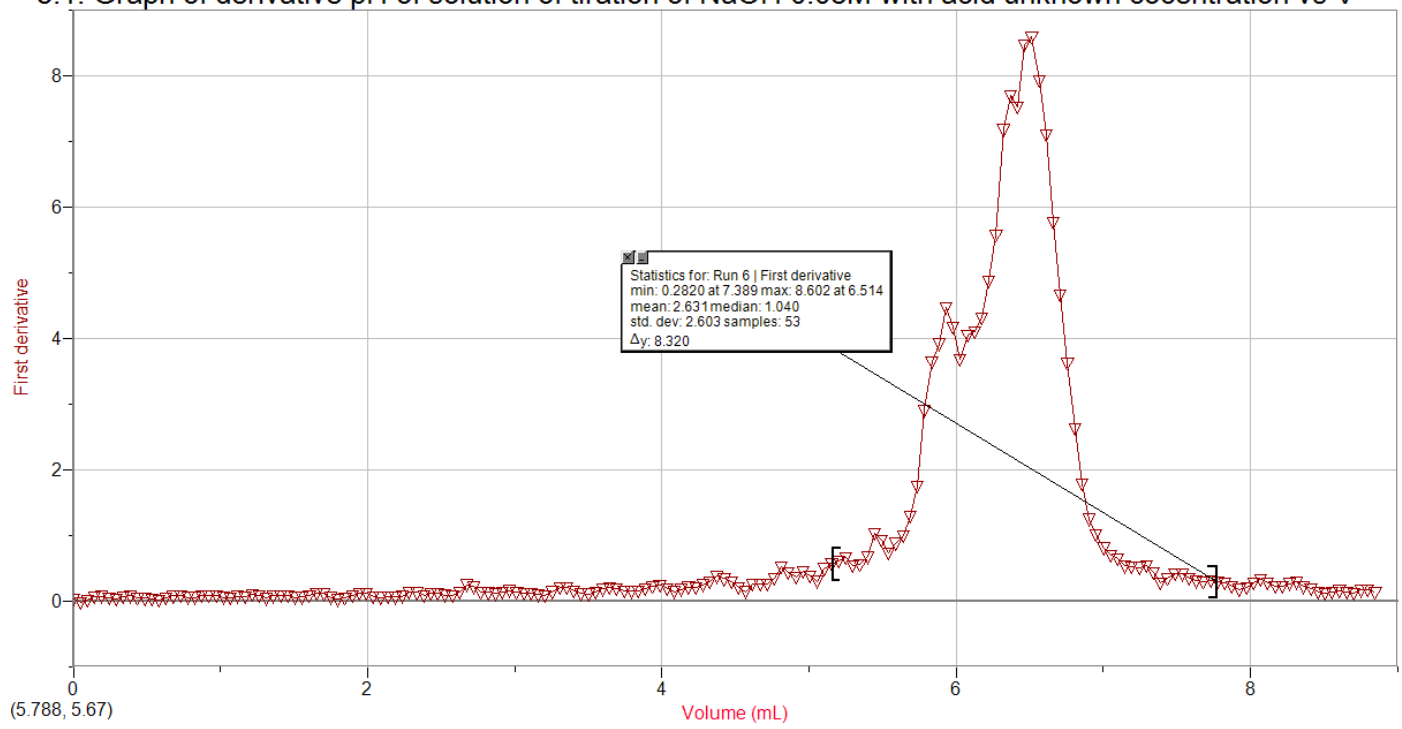


Trial 5 (run 6 in logger pro): finding the concentration of unknown acid #2

Figure 5.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

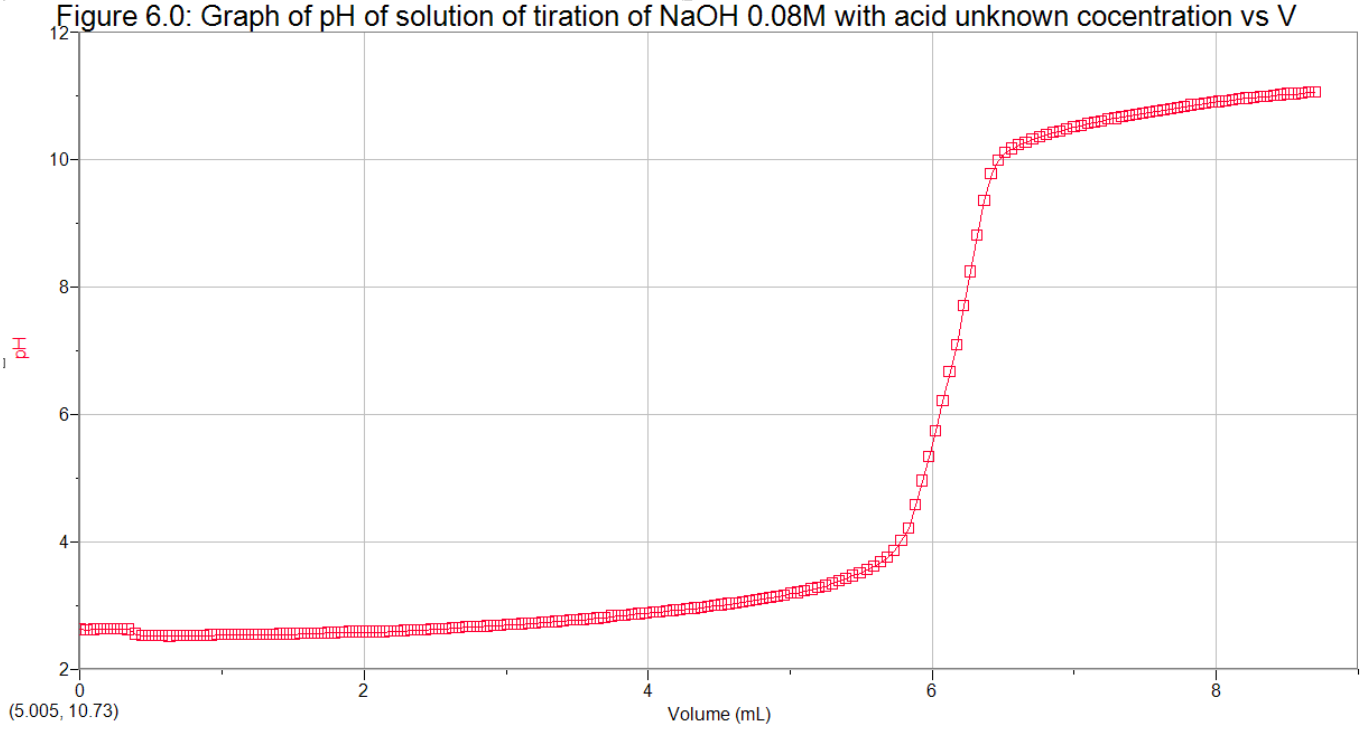


5.1: Graph of derivative pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

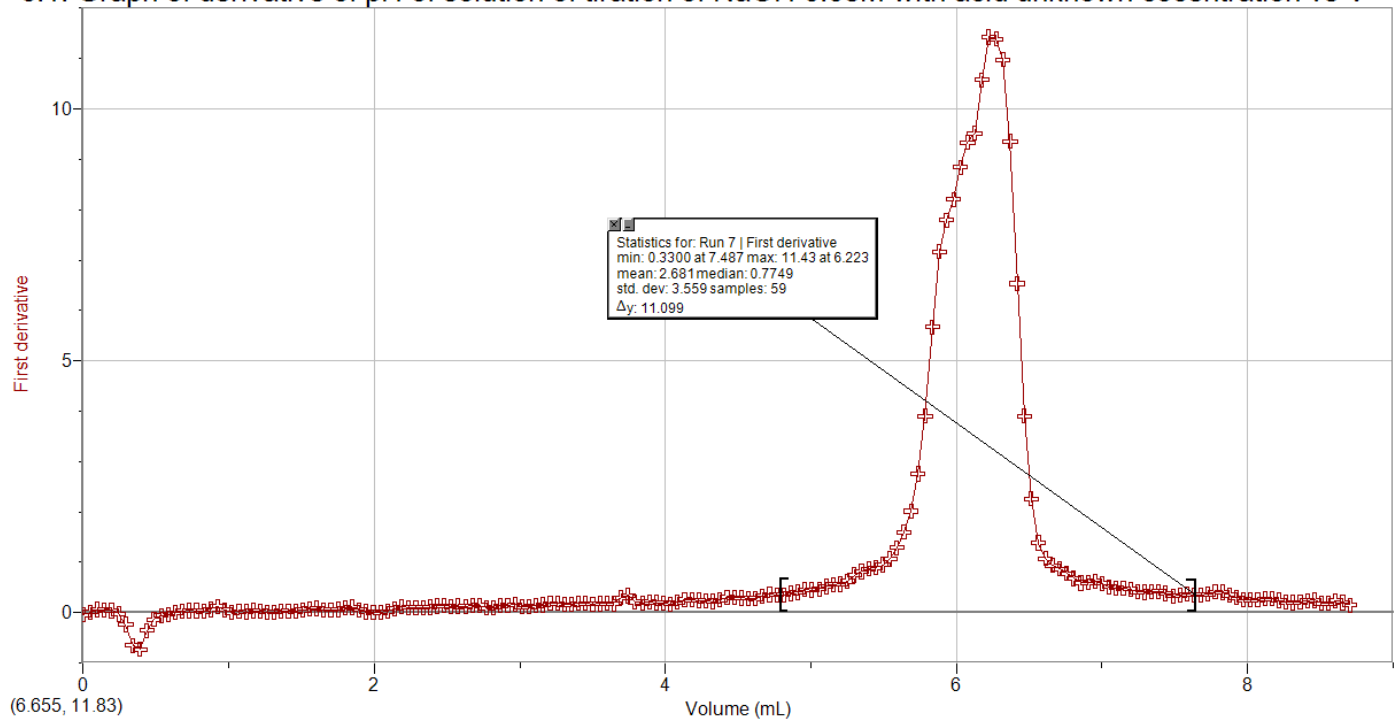


Trial 6 (run 7 in logger pro): finding the concentration of unknown acid #2

Figure 6.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

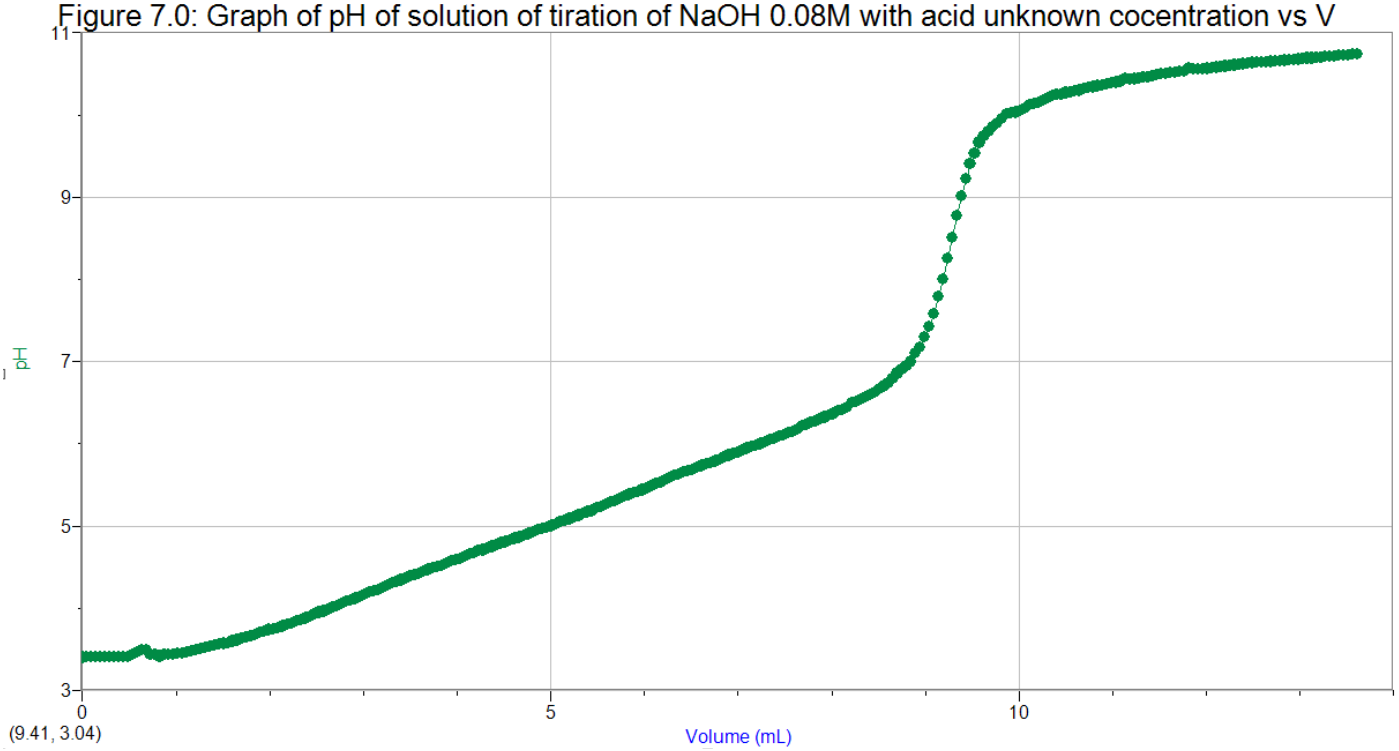


6.1: Graph of derivative of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

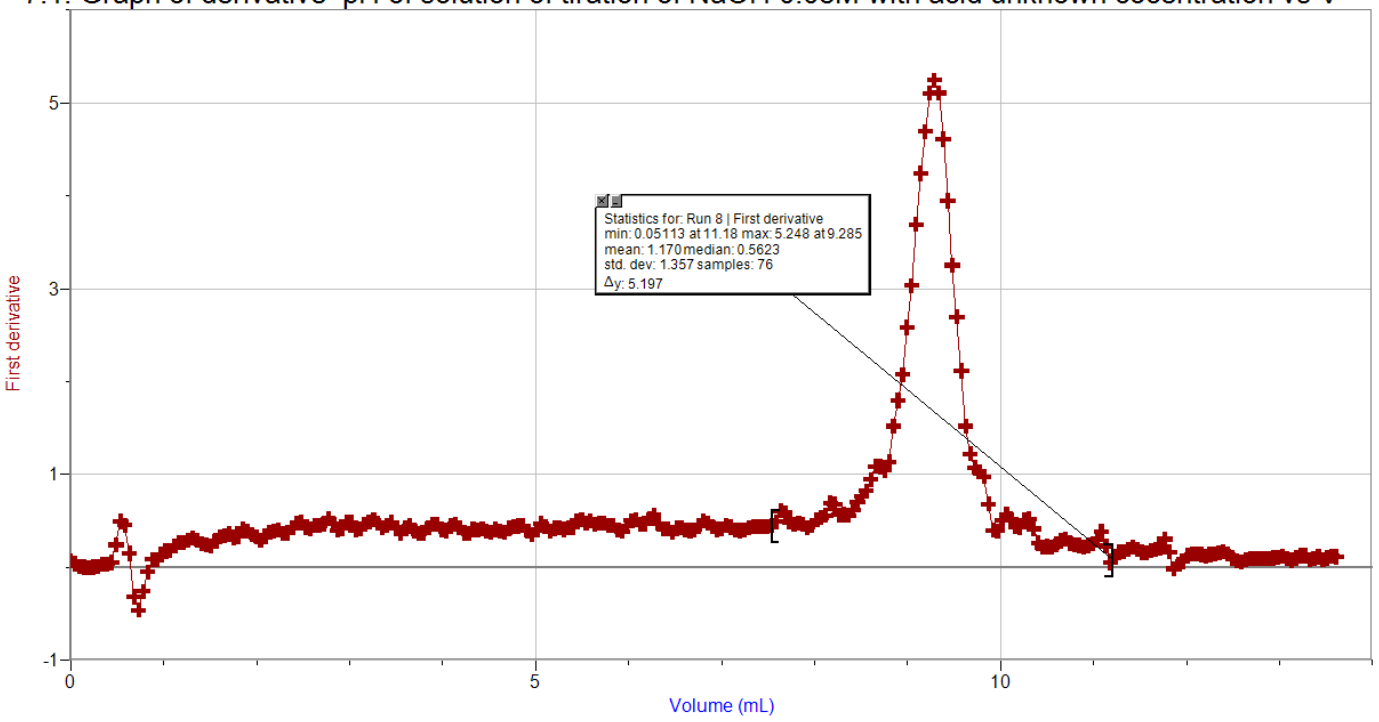


Trial 7 (run 8 in logger pro): finding the concentration of acid in juice #1

Figure 7.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

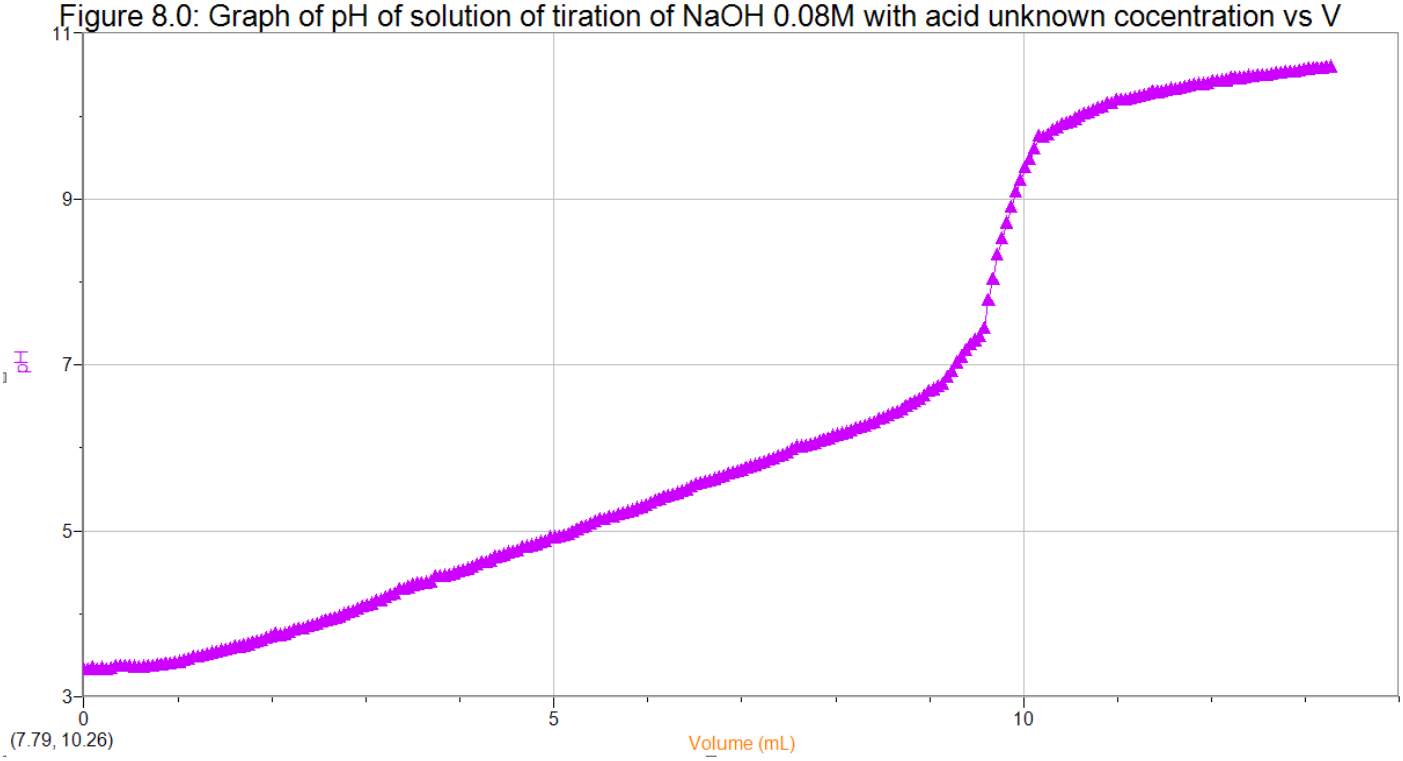


7.1: Graph of derivative pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

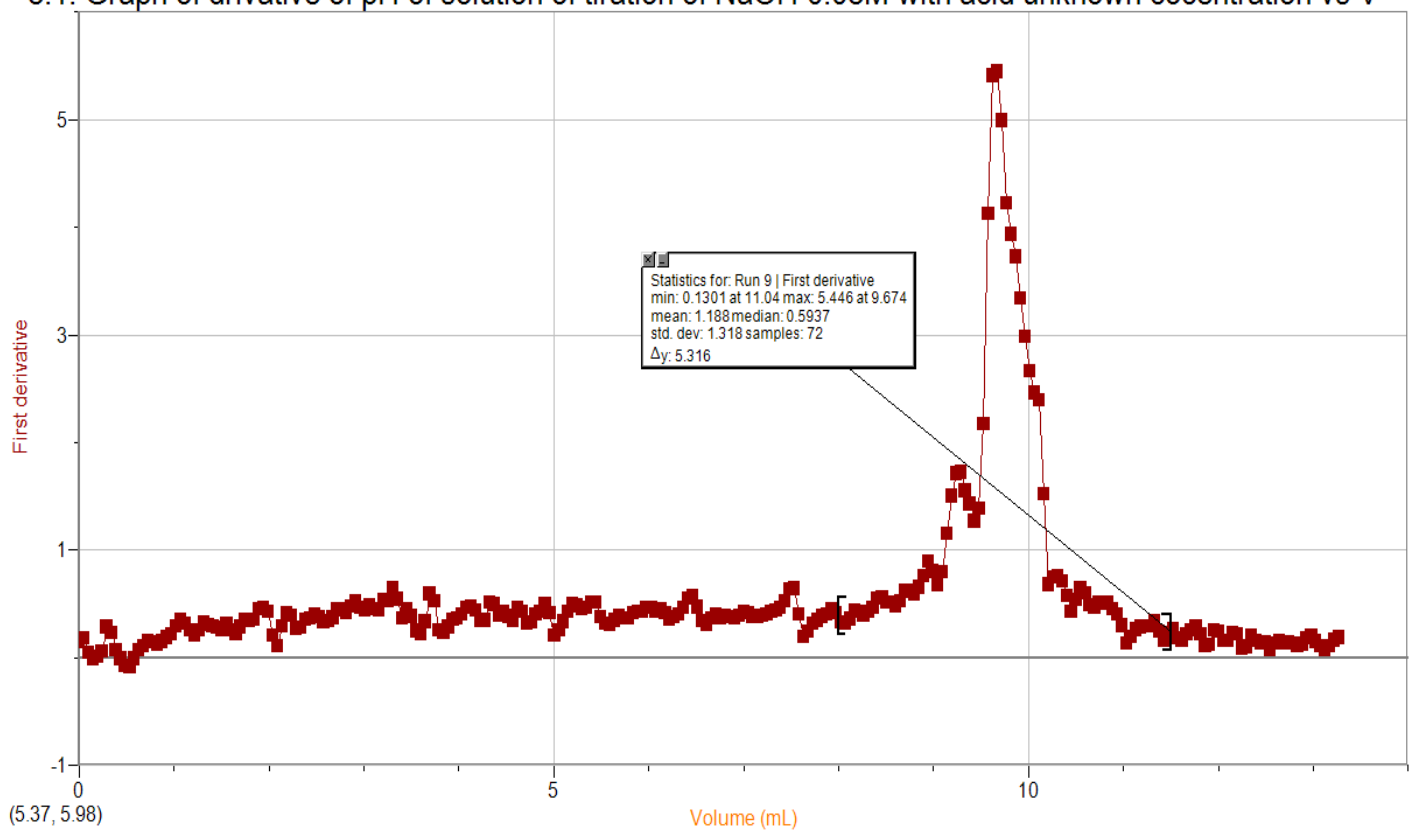


Trial 8 (run 9 in logger pro): finding the concentration of acid in juice #1

Figure 8.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

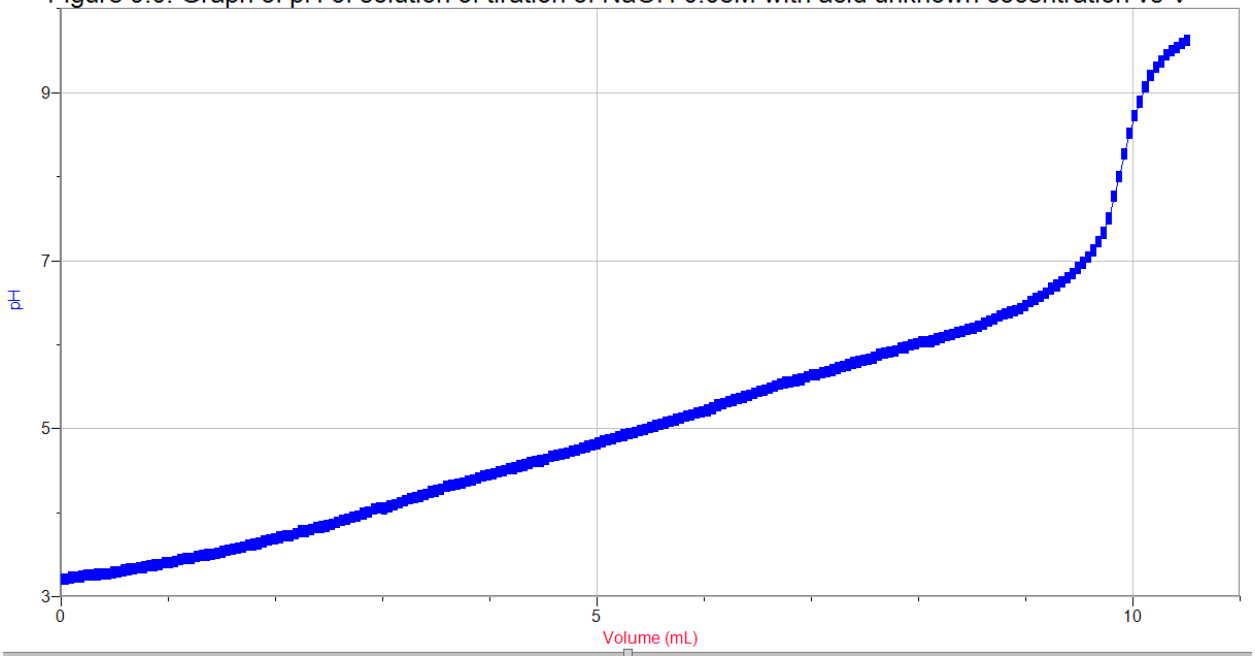


8.1: Graph of drivative of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V

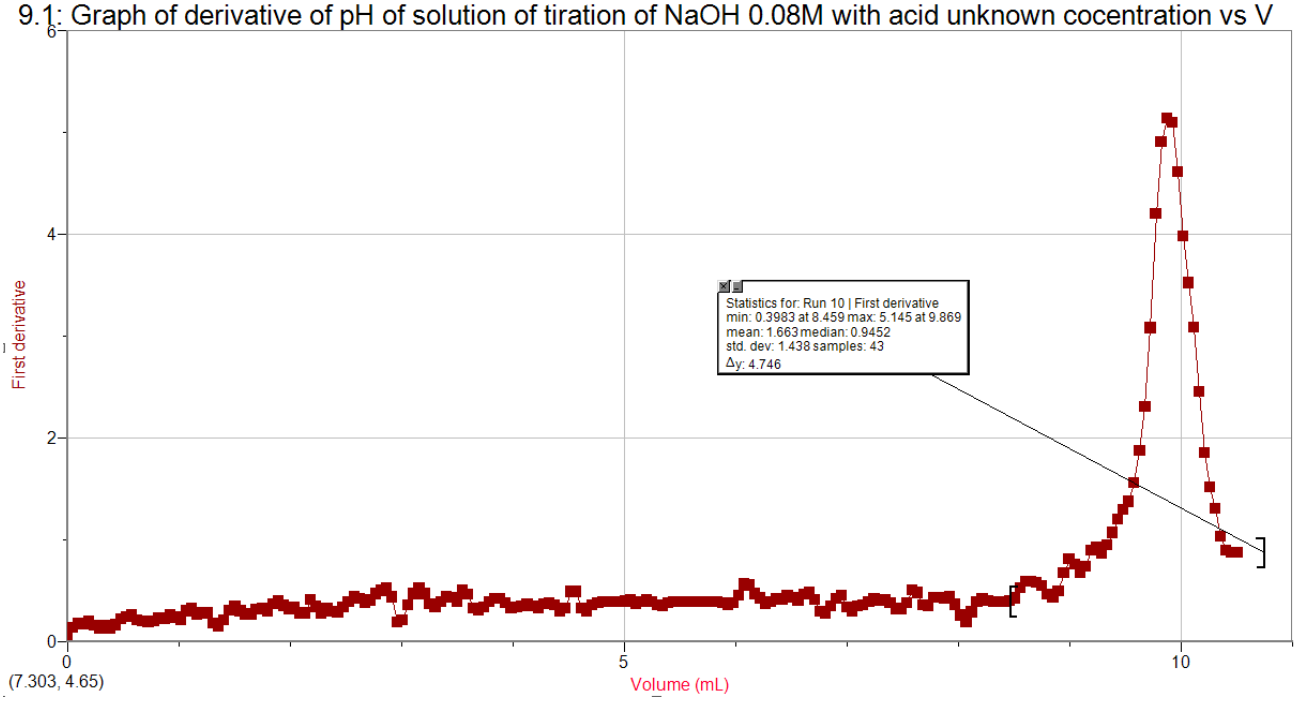


Trial 9 (run 10 in logger pro): finding the concentration of acid in juice #1

Figure 9.0: Graph of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V



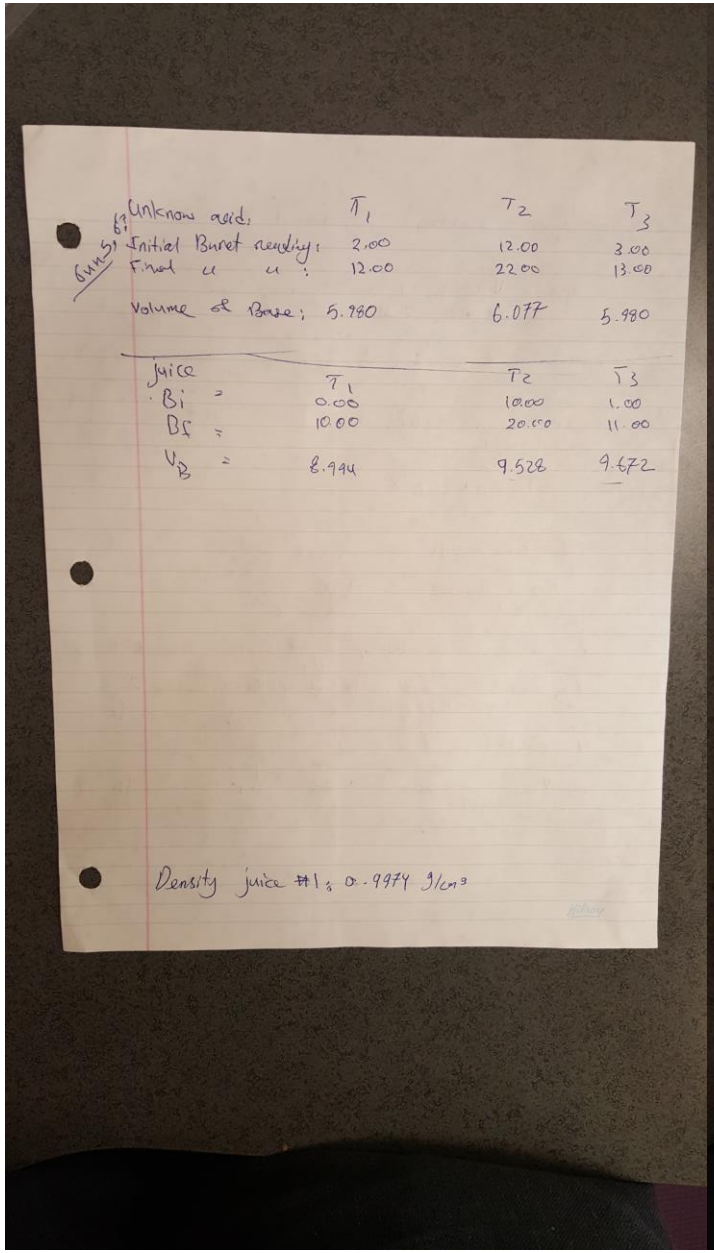
9.1: Graph of derivative of pH of solution of tiration of NaOH 0.08M with acid unknown cocentration vs V



Raw data:

	Run 1			Run 2			Run 3			Run 4			Run 5			Run 6		
	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	F
1	0.000	5.86	-0.143	0.000	1.91	0.307	0.000	2.32	-0.053	0.000	2.55	-0.023	0.000	2.70	0.000	0.000	2.60	
2	0.047	5.86	-0.171	0.049	1.93	0.211	0.049	2.32	-0.015	0.049	2.55	-0.049	0.049	2.70	0.000	0.049	2.61	
3	0.093	5.84	-0.142	0.097	1.94	0.121	0.097	2.32	-0.011	0.097	2.54	-0.066	0.097	2.70	0.000	0.097	2.60	
4	0.140	5.84	-0.092	0.146	1.94	0.068	0.146	2.32	-0.026	0.146	2.54	-0.105	0.146	2.70	0.000	0.146	2.61	
5	0.187	5.84	-0.111	0.194	1.94	0.053	0.194	2.32	-0.008	0.194	2.54	-0.157	0.194	2.70	0.000	0.194	2.61	
6	0.234	5.83	-0.140	0.243	1.95	0.050	0.243	2.32	-0.008	0.243	2.53	-0.142	0.243	2.70	0.000	0.243	2.62	
7	0.280	5.82	-0.142	0.292	1.95	0.048	0.292	2.32	-0.022	0.292	2.52	-0.112	0.292	2.70	0.000	0.292	2.61	
8	0.327	5.82	-0.109	0.340	1.95	0.048	0.340	2.32	-0.068	0.340	2.52	-0.102	0.340	2.70	0.000	0.340	2.62	
9	0.374	5.81	-0.090	0.389	1.95	0.048	0.389	2.31	-0.063	0.389	2.51	-0.106	0.389	2.70	0.000	0.389	2.62	
10	0.421	5.81	-0.055	0.438	1.96	0.051	0.438	2.31	0.002	0.438	2.51	-0.119	0.438	2.70	0.000	0.438	2.63	
11	0.467	5.81	-0.112	0.486	1.96	0.058	0.486	2.31	-0.005	0.486	2.50	-0.083	0.486	2.70	0.000	0.486	2.63	
12	0.514	5.80	-0.185	0.535	1.96	0.076	0.535	2.31	-0.024	0.535	2.50	-0.027	0.535	2.70	0.000	0.535	2.63	
13	0.561	5.79	-0.131	0.583	1.97	0.056	0.583	2.31	-0.008	0.583	2.50	-0.017	0.583	2.70	0.000	0.583	2.63	
14	0.607	5.79	-0.093	0.632	1.97	0.051	0.632	2.31	-0.003	0.632	2.50	-0.037	0.632	2.70	0.000	0.632	2.63	
15	0.654	5.78	-0.047	0.681	1.97	0.048	0.681	2.31	0.000	0.681	2.49	-0.034	0.681	2.70	0.000	0.681	2.63	
16	0.701	5.78	0.075	0.729	1.97	0.050	0.729	2.31	-0.003	0.729	2.49	0.000	0.729	2.70	0.000	0.729	2.64	
17	0.748	5.80	-0.121	0.778	1.98	0.050	0.778	2.31	-0.011	0.778	2.49	0.034	0.778	2.70	0.000	0.778	2.64	
18	0.794	5.76	-0.264	0.826	1.98	0.046	0.826	2.31	-0.037	0.826	2.50	0.037	0.826	2.70	0.000	0.826	2.64	
19	0.841	5.77	-0.235	0.875	1.98	0.040	0.875	2.30	-0.037	0.875	2.50	0.011	0.875	2.70	0.000	0.875	2.65	
20	0.888	5.75	-0.229	0.924	1.98	0.024	0.924	2.30	-0.011	0.924	2.50	0.003	0.924	2.70	0.000	0.924	2.65	
21	0.935	5.75	-0.158	0.972	1.98	0.052	0.972	2.30	-0.005	0.972	2.50	0.003	0.972	2.70	0.000	0.972	2.66	
22	0.981	5.74	-0.193	1.021	1.99	0.082	1.021	2.30	-0.011	1.021	2.50	0.013	1.021	2.70	0.000	1.021	2.66	
23	1.028	5.73	-0.200	1.070	1.99	0.083	1.070	2.30	-0.032	1.070	2.50	0.042	1.070	2.70	0.000	1.070	2.66	
24	1.075	5.72	-0.193	1.118	1.99	0.059	1.118	2.30	-0.029	1.118	2.50	0.061	1.118	2.70	0.000	1.118	2.67	
25	1.121	5.71	-0.159	1.167	1.99	0.052	1.167	2.30	0.003	1.167	2.51	0.021	1.167	2.70	0.003	1.167	2.67	
26	1.168	5.70	-0.130	1.215	2.00	0.050	1.215	2.30	-0.037	1.215	2.50	0.013	1.215	2.70	0.008	1.215	2.67	
27	1.215	5.70	-0.139	1.264	2.00	0.048	1.264	2.29	-0.058	1.264	2.51	0.026	1.264	2.70	0.026	1.264	2.69	
28	1.262	5.69	-0.121	1.313	2.00	0.051	1.313	2.29	-0.019	1.313	2.51	0.011	1.313	2.71	0.011	1.313	2.68	
29	1.308	5.68	-0.052	1.361	2.00	0.056	1.361	2.29	-0.008	1.361	2.51	0.017	1.361	2.70	0.011	1.361	2.69	
30	1.355	5.69	-0.073	1.410	2.01	0.076	1.410	2.29	-0.011	1.410	2.51	0.047	1.410	2.71	0.026	1.410	2.69	
31	1.402	5.68	-0.130	1.458	2.01	0.058	1.458	2.29	-0.037	1.458	2.51	0.071	1.458	2.71	0.008	1.458	2.70	

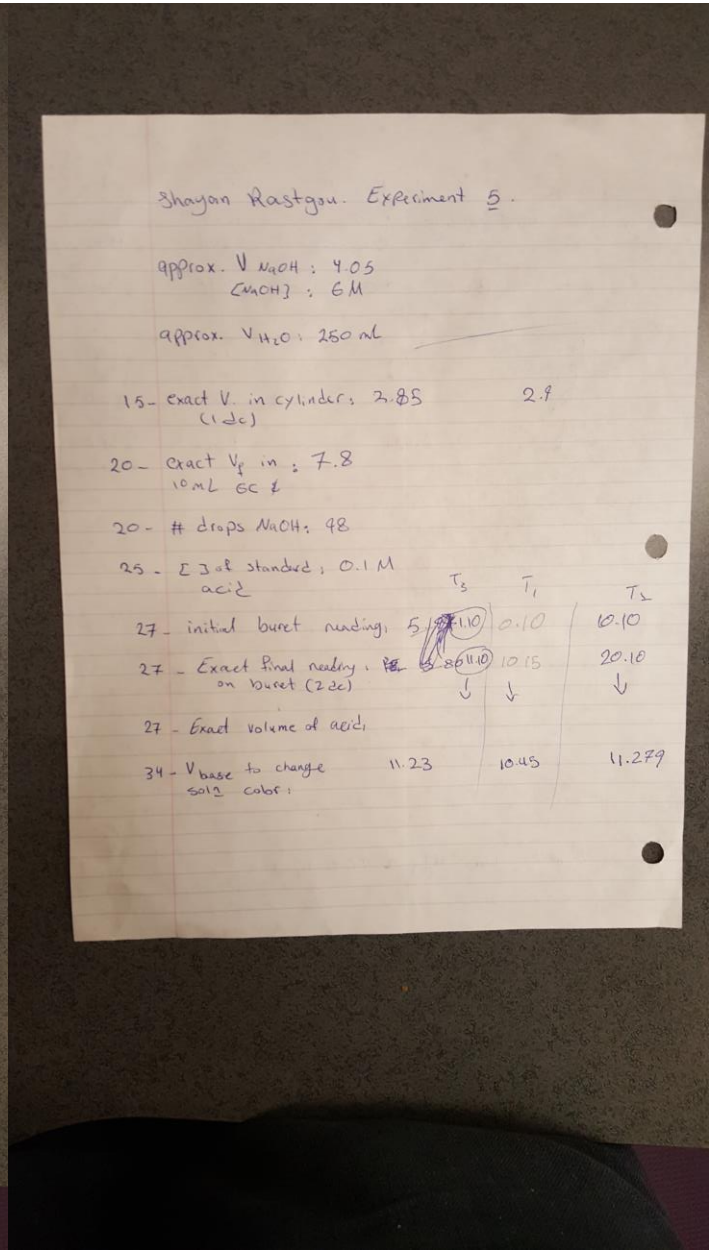
	Run 6		Run 7			Run 8			Run 9			Run 10		
	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD	Volume (mL)	pH	FD
1	2.60	0.036	0.000	2.63	-0.045	0.000	3.40	0.069	0.000	3.31	0.150	0.000	3.21	0.070
2	2.61	-0.011	0.049	2.62	0.015	0.049	3.41	0.038	0.049	3.31	0.177	0.049	3.21	0.140
3	2.60	0.018	0.097	2.63	0.063	0.097	3.41	0.011	0.097	3.34	0.044	0.097	3.23	0.175
4	2.61	0.071	0.146	2.63	0.053	0.146	3.41	0.003	0.146	3.31	-0.013	0.146	3.23	0.170
5	2.61	0.079	0.194	2.63	0.043	0.194	3.41	0.000	0.194	3.33	0.009	0.194	3.24	0.201
6	2.62	0.055	0.243	2.63	-0.025	0.243	3.41	0.003	0.243	3.31	0.061	0.243	3.26	0.157
7	2.61	0.035	0.292	2.63	-0.235	0.292	3.41	0.011	0.292	3.33	0.286	0.292	3.26	0.130
8	2.62	0.075	0.340	2.63	-0.650	0.340	3.41	0.032	0.340	3.36	0.233	0.340	3.27	0.156
9	2.62	0.082	0.389	2.55	-0.729	0.389	3.41	0.037	0.389	3.36	0.068	0.389	3.28	0.129
10	2.63	0.060	0.438	2.53	-0.355	0.438	3.41	0.052	0.438	3.36	-0.008	0.438	3.28	0.163
11	2.63	0.048	0.486	2.53	-0.132	0.486	3.41	0.242	0.486	3.36	-0.079	0.486	3.29	0.222
12	2.63	0.040	0.535	2.53	-0.056	0.535	3.43	0.493	0.535	3.35	-0.092	0.535	3.30	0.243
13	2.63	0.024	0.583	2.53	-0.036	0.583	3.47	0.455	0.583	3.34	-0.008	0.583	3.31	0.261
14	2.63	0.051	0.632	2.52	0.000	0.632	3.49	0.152	0.632	3.35	0.072	0.632	3.33	0.215
15	2.63	0.082	0.681	2.53	0.036	0.681	3.49	-0.317	0.681	3.35	0.111	0.681	3.33	0.200
16	2.64	0.084	0.729	2.53	0.043	0.729	3.44	-0.461	0.729	3.36	0.161	0.729	3.35	0.197
17	2.64	0.062	0.778	2.53	0.040	0.778	3.43	-0.259	0.778	3.37	0.144	0.778	3.35	0.204
18	2.64	0.063	0.826	2.53	0.030	0.826	3.42	-0.048	0.826	3.37	0.125	0.826	3.37	0.228
19	2.65	0.087	0.875	2.53	0.066	0.875	3.43	0.084	0.875	3.38	0.149	0.875	3.37	0.222
20	2.65	0.091	0.924	2.54	0.123	0.924	3.43	0.086	0.924	3.38	0.186	0.924	3.38	0.258
21	2.66	0.087	0.972	2.55	0.056	0.972	3.44	0.138	0.972	3.40	0.220	0.972	3.40	0.239
22	2.66	0.063	1.021	2.54	-0.001	1.021	3.45	0.174	1.021	3.40	0.289	1.021	3.41	0.216
23	2.66	0.059	1.070	2.54	0.023	1.070	3.46	0.178	1.070	3.43	0.345	1.070	3.42	0.302
24	2.67	0.080	1.118	2.54	0.016	1.118	3.46	0.232	1.118	3.44	0.320	1.118	3.44	0.330
25	2.67	0.075	1.167	2.54	0.039	1.167	3.48	0.267	1.167	3.46	0.252	1.167	3.46	0.261
26	2.67	0.111	1.215	2.55	0.037	1.215	3.49	0.265	1.215	3.46	0.203	1.215	3.46	0.282
27	2.69	0.087	1.264	2.55	0.014	1.264	3.50	0.293	1.264	3.47	0.255	1.264	3.48	0.279
28	2.68	0.046	1.313	2.55	0.013	1.313	3.52	0.315	1.313	3.49	0.330	1.313	3.49	0.181
29	2.69	0.082	1.361	2.55	0.034	1.361	3.54	0.291	1.361	3.51	0.306	1.361	3.50	0.148
30	2.69	0.090	1.410	2.55	0.037	1.410	3.55	0.255	1.410	3.52	0.293	1.410	3.50	0.210
31	2.70	0.088	1.458	2.55	0.024	1.458	3.56	0.241	1.458	3.54	0.282	1.458	3.52	0.209



Unknown acid:	T_1	T_2	T_3
Initial Buret reading:	2.00	12.00	3.00
Final " " :	12.00	22.00	13.00
Volume of Base:	5.980	6.077	5.980

Juice	T_1	T_2	T_3
B_i =	0.00	10.00	1.00
B_f =	10.00	20.00	11.00
V_B =	8.944	9.528	9.672

Density juice #1: 0.9974 g/cm³



Shayan Rastgou. Experiment 5.

approx. V_{NaOH}: 4.05
$[NaOH]$: 6M

approx. V_{H_2O}: 250 mL

15- exact V. in cylinder: 2.85 2.9
(1 dc)

20- exact V_f in : 7.8
10 mL 6C ℓ

20- # drops NaOH: 98

25- [ ] of standard: 0.1 M
acid

	T_3	T_1	T_2
27- initial buret reading:	5.10	0.10	10.10
27- Exact final reading on buret (2 dc)	11.10	10.15	20.10
27- Exact volume of acid:			
34- V_{base} to change sol'n color:	11.23	10.45	11.279

Sample Calculation: (Part 1)

1. Approximate concentration of stock solution

   [NaOH] = 6M

   Vi(NaOH): 4.05 ml

   V_{H2O} = 250 ml

   $C_iV_i = C_fV_f$

   $(4.05)(6) = C_f (250+4.05)$

   $C_f = 0.09650$ M

Sample Calculation: (Part 2)

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

[Standard Acid] = 0.1 M

Trial 2:

Initial acid volume reading on burette: 10.10 ml

Final acid volume reading on burette: 20.10 ml

Exact volume of acid: 10.00 ml

Monoprotic acid → $C_bV_b = C_aV_a$

$C_b = (C_aV_a)/(V_b)$

Vb(observed): 11.279 ml

Cb = (0.1)(10)/(11.279)

= 0.08866 M

Vb(logger pro): 11.76

Cb= (0.1)(10)/11.76

= 0.08503 M

3. Average concentration of stock solution:

Average between results for trials 2 and 3 :

0.08502 + 0.08718 /2 = 0.086105 M

Sample Calculation: (Part 3)

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

[NaOH] = 0.086105 M

Trial 1:

Initial acid volume reading on burette: 2.00 ml

Final acid volume reading on burette: 12.00 ml

Exact volume of acid: 10.00 ml

Diprotic acid → CbVb = 2CaVa

$$Ca = (CbVb)/2(Va)$$

Vb (observed): 5.980 ml

Ca= (0.086105)(5.980)/20.00
= 0.02574 M

Vb (logger Pro): 6.3320 ml

Ca= (0.086105)(6.320)/20.00
= 0.027209 M

5. Average concentration of unknown acid:

All three trials:
0.027209 + 0.02804 + 0.002679 / 3 = 0.027346 M

Sample Calculation: (Part 4)

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

[NaOH] = 0.086105 M

Trial 3:

Initial acid volume reading on burette: 3.00 ml

Final acid volume reading on burette: 13.00 ml

Exact volume of acid: 10.00 ml

Triprotic acid → CbVb = 3CaVa

$$Ca = (CbVb)/3(Va)$$

Vb (observed): 9.672 ml

Ca= (0.086105)(9.672)/30.00
= 0.0283256 M

Vb (logger Pro): 9.869

Ca= (0.086105)(9.869)/30.00
= 0.0283256 M

7. Average concentration of acid in juice:

Trials 2 and 3:

0.0277659 + 0.0283256 / 2 = 0.0280 M

8. Mass percentage of acid in juice: MMacid: 8(1.008) + 6(12.011) + 7(15.999) = 192.123 g/mol

Mass % A in J = ([acid] x MMacid / d juice x 1000) x 100

Using the AVG [HA] :

((0.0280)(192.123)/(0.9974)(1000))* 100 = 0.54%

Discussion (in space provided):

The purpose of this experiment is to practice the skills needed for titration. Titration, in chemistry, is used to determine the concentration of an unknown acid using a base with known concentration and vice versa. We also calculated the mass percentage of acid in a juice. As for observations, since we have added an indicator that changes color in solution when the pH of solution reaches a range close to 7.00 (natural pH), we noted the volume that initiated the color change. Although our observation results were reproducible for the most part, the exact volume of NaOH taken from logger pro had a slight difference with ours. The reason for this is that we may have been looking for the wrong 'instant'. The colour change is very rapid and we tried to note the exact volume that initiated the change, but the time would have actually been one or two drops after.

Furthermore, in some of our graphs, for example figure 4.1, there are extra spikes in plotted which is because the speed at which our plastic burette released drops of base was too fast. In Our calculation we still took the highest peak as the end point for titration. The biggest source of error in this experiment, which is a human error, is cross contamination. It is possible for one to forget to rinse one of the beaker that he or she is using an start the process of neutralization sooner than it should happen. Then the endpoint of titration is going to be sooner and the results would be off.

Conclusion: (2 sentences. Please note that the values you state as your results in this section will be used to determine your grade out of 5 for the results. Please include your unknown acid number and your juice name in this section.)

The concentration of strong base, NaOH was calculated to be 0.086105 M which used to calculate the concentration of unknown acid number 2 to be 0.027346 M. It was also used to calculate the concentration of acid in juice number 1 which is 0.0280, the mass percentage of this acid is 0.54%.