

*November 9th 2018*  
*TA: Pegah Tavangar*

CHEM 1311

# **General Chemistry Laboratory**

“OH HOW BITTER A THING IS...”

Acid/Base Titration

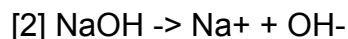
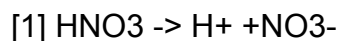
*Written by: Emilie Lachapelle 300060189*

## ***Introduction***

If you are a pool owner, you know that you need to regularly test your water's pH level to ensure that it remains in between 7.2 and 7.8. A pH that is too high or too low, might cause damage to the the equipment used inside the pool and cloud the water. In order to determine if the pool water is too acidic or basic, people generally use pH testing strips as indicators. These change colours according to the pH level of the pool. In this lab we will be determining the amount of base required to neutralize an acid. The use of a pH indicator, in this case phenolphthalein, will allow us to see almost exactly how much base it takes for the neutralization to occur, since the solution will change colour. If the indicator has carefully been selected, the equivalence point and end point will be similar.

To begin, an acid is a substance which typically has a sour taste and when it is considered to be strong, it is corrosive. A substance is only considered an acid if its pH level is in between 0 and 7. According to the *Arrhenius* definition, acidic substances tend to give away a H<sup>+</sup> proton [1]. Similarly to the acids, bases are also corrosif when the are deemed to be strong, however, they usually have a bitter taste and their pH level is found in between 7 and 14. They are also OH<sup>-</sup> donors if you reference the same definition[2].

The following are examples that demonstrates the behaviour of acidic and basic substances dissolving in water, respectively.



*Arrhenius's* definition has shown to have certain restrictions when some substances were found to behave as a H<sup>+</sup> donor, as well as an OH<sup>-</sup> donor simultaneously . This is when the *Bronsted-Lowry* definition comes in handy. In depth, the acid's primary interpretation remains the same whereas the base is now define as a substance that

can accept H<sup>+</sup> protons. Since this lab session uses solely hydrogen ions and hydroxide ions, we will be basing ourselves off of the *Arrhenius* definition.

Moreover, it is possible to calculate the concentration of an unknown acid or base using the following equation.

$$\text{Concentration} = \frac{\text{Amount of solute (acid or base)(mol)}}{\text{Volume of Solution (L)}}$$

This concept will be important for the procedure of this experiment since we will be diluting NaOH with distilled water. It is basically the same concept for both acids and bases, if there is a smaller amount of water mixed with the substance, then its concentration will be higher. If the amount of water is quite significant, the concentration will not be as strong. On top of that, it will allow us to determine the concentration of the unknown acids we will be working with.

## Procedure

As described in lab manual (Acid/Base Titrations, By Dr. Rashmi, Exp. 4, Page 18-82).

## Data Tables

### Part 1: Standardizing Diluted NaOH solution, determining the concentration of NaOH

TRIALS	1	2	3
Volume of the acid inside the solution in mL (Initial volume inside buret - final volume in buret)	(24.25-14.22) =9.98	(23.97-13.65) =10.65	(22.78-12.33) =10.45mL
Volume of base added to generate a change in colour (mL)	11.2	12.1	14.79

### Part 2: Determining the concentration of an unknown acid, #3

TRIALS	1	2	3
Volume of the acid inside the solution in mL (Initial volume inside buret - final volume in buret)	(22.76-12.91) =9.85	(21.55-12.53) =9.02	(24.39-14.15) =10.24
Volume of base added to generate a change in colour (mL)	18.755	21.38	22.206

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
2	0.075	2.35	0.075	2.38	0.075	2.46	0.075	2.76	0.075	2.72	0.075	2.69
3	0.150	2.35	0.150	2.37	0.150	2.46	0.150	2.86	0.150	2.68	0.150	2.68
4	0.225	2.35	0.225	2.37	0.225	2.46	0.225	2.88	0.225	2.68	0.225	2.68
5	0.300	2.35	0.300	2.38	0.300	2.45	0.300	2.86	0.300	2.68	0.300	2.68
6	0.375	2.35	0.375	2.37	0.375	2.45	0.375	2.92	0.375	2.67	0.375	2.68
7	0.450	2.35	0.450	2.38	0.450	2.45	0.450	2.91	0.450	2.67	0.450	2.68
8	0.525	2.35	0.525	2.38	0.525	2.44	0.525	2.92	0.525	2.67	0.525	2.69
9	0.600	2.35	0.600	2.38	0.600	2.42	0.600	2.89	0.600	2.67	0.600	2.71
10	0.675	2.35	0.675	2.39	0.675	2.42	0.675	2.87	0.675	2.67	0.675	2.72
11	0.750	2.35	0.750	2.39	0.750	2.41	0.750	3.03	0.750	2.68	0.750	2.71
12	0.825	2.35	0.825	2.38	0.825	2.41	0.825	2.93	0.825	2.68	0.825	2.71
13	0.900	2.35	0.900	2.38	0.900	2.41	0.900	2.91	0.900	2.69	0.900	2.70
14	0.975	2.35	0.975	2.39	0.975	2.40	0.975	2.98	0.975	2.68	0.975	2.69
15	1.050	2.35	1.050	2.40	1.050	2.41	1.050	2.96	1.050	2.68	1.050	2.70
16	1.125	2.35	1.125	2.41	1.125	2.40	1.125	3.01	1.125	2.68	1.125	2.71
17	1.200	2.35	1.200	2.40	1.200	2.40	1.200	2.96	1.200	2.68	1.200	2.73
18	1.275	2.35	1.275	2.40	1.275	2.40	1.275	2.96	1.275	2.68	1.275	2.77
19	1.350	2.35	1.350	2.40	1.350	2.40	1.350	3.04	1.350	2.68	1.350	2.74
20	1.425	2.35	1.425	2.42	1.425	2.40	1.425	2.97	1.425	2.69	1.425	2.73
21	1.500	2.35	1.500	2.41	1.500	2.41	1.500	3.03	1.500	2.69	1.500	2.73
22	1.575	2.35	1.575	2.41	1.575	2.43	1.575	2.99	1.575	2.69	1.575	2.71
23	1.650	2.35	1.650	2.40	1.650	2.41	1.650	3.03	1.650	2.69	1.650	2.72
24	1.725	2.35	1.725	2.40	1.725	2.40	1.725	3.09	1.725	2.69	1.725	2.73
25	1.800	2.35	1.800	2.40	1.800	2.41	1.800	3.07	1.800	2.69	1.800	2.75
26	1.875	2.35	1.875	2.41	1.875	2.41	1.875	3.05	1.875	2.69	1.875	2.73
27	1.950	2.35	1.950	2.41	1.950	2.40	1.950	3.03	1.950	2.69	1.950	2.82
28	2.026	2.35	2.026	2.41	2.026	2.40	2.026	3.13	2.026	2.69	2.026	2.77
29	2.101	2.36	2.101	2.41	2.101	2.41	2.101	3.11	2.101	2.69	2.101	2.75
30	2.176	2.35	2.176	2.41	2.176	2.43	2.176	3.06	2.176	2.70	2.176	2.74
31	2.251	2.35	2.251	2.41	2.251	2.43	2.251	3.09	2.251	2.70	2.251	3.05
32	2.326	2.35	2.326	2.42	2.326	2.41	2.326	3.11	2.326	2.71	2.326	2.77
33	2.401	2.35	2.401	2.41	2.401	2.42	2.401	3.08	2.401	2.70	2.401	2.76
34	2.476	2.36	2.476	2.43	2.476	2.42	2.476	3.08	2.476	2.70	2.476	2.77
35	2.551	2.35	2.551	2.42	2.551	2.43	2.551	3.23	2.551	2.71	2.551	2.80

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
35	2.551	2.35	2.551	2.42	2.551	2.43	2.551	3.23	2.551	2.71	2.551	2.80
36	2.626	2.35	2.626	2.42	2.626	2.43	2.626	3.18	2.626	2.71	2.626	2.80
37	2.701	2.36	2.701	2.44	2.701	2.43	2.701	3.23	2.701	2.71	2.701	2.75
38	2.776	2.36	2.776	2.43	2.776	2.42	2.776	3.22	2.776	2.71	2.776	2.74
39	2.851	2.35	2.851	2.45	2.851	2.41	2.851	3.16	2.851	2.72	2.851	2.80
40	2.926	2.35	2.926	2.44	2.926	2.43	2.926	3.34	2.926	2.74	2.926	2.76
41	3.001	2.36	3.001	2.44	3.001	2.42	3.001	3.25	3.001	2.73	3.001	2.81
42	3.076	2.36	3.076	2.44	3.076	2.43	3.076	3.27	3.076	2.73	3.076	2.85
43	3.151	2.36	3.151	2.44	3.151	2.43	3.151	3.46	3.151	2.73	3.151	2.81
44	3.226	2.36	3.226	2.44	3.226	2.49	3.226	3.52	3.226	2.73	3.226	2.78
45	3.301	2.36	3.301	2.45	3.301	2.43	3.301	3.55	3.301	2.73	3.301	2.77
46	3.376	2.36	3.376	2.44	3.376	2.44	3.376	3.44	3.376	2.73	3.376	2.78
47	3.451	2.36	3.451	2.44	3.451	2.52	3.451	3.40	3.451	2.74	3.451	2.77
48	3.526	2.36	3.526	2.45	3.526	2.46	3.526	3.43	3.526	2.76	3.526	2.77
49	3.601	2.36	3.601	2.45	3.601	2.44	3.601	3.47	3.601	2.76	3.601	2.77
50	3.676	2.36	3.676	2.45	3.676	2.45	3.676	3.38	3.676	2.76	3.676	2.77
51	3.751	2.36	3.751	2.46	3.751	2.44	3.751	3.36	3.751	2.77	3.751	2.79
52	3.826	2.36	3.826	2.47	3.826	2.45	3.826	3.58	3.826	2.77	3.826	2.87
53	3.901	2.36	3.901	2.47	3.901	2.45	3.901	3.68	3.901	2.77	3.901	2.83
54	3.976	2.36	3.976	2.46	3.976	2.45	3.976	3.81	3.976	2.77	3.976	2.81
55	4.051	2.36	4.051	2.46	4.051	2.45	4.051	3.86	4.051	2.79	4.051	2.82
56	4.126	2.36	4.126	2.46	4.126	2.46	4.126	3.83	4.126	2.78	4.126	2.81
57	4.201	2.36	4.201	2.47	4.201	2.45	4.201	3.87	4.201	2.78	4.201	2.80
58	4.276	2.36	4.276	2.47	4.276	2.45	4.276	3.81	4.276	2.81	4.276	2.85
59	4.351	2.36	4.351	2.47	4.351	2.45	4.351	3.87	4.351	2.83	4.351	3.06
60	4.426	2.36	4.426	2.48	4.426	2.45	4.426	3.87	4.426	2.80	4.426	2.87
61	4.501	2.36	4.501	2.51	4.501	2.46	4.501	4.00	4.501	2.80	4.501	2.82
62	4.576	2.36	4.576	2.50	4.576	2.47	4.576	3.98	4.576	2.81	4.576	2.86
63	4.651	2.56	4.651	2.84	4.651	2.48	4.651	4.05	4.651	2.81	4.651	2.85
64	4.726	2.56	4.726	2.50	4.726	2.48	4.726	4.28	4.726	2.81	4.726	2.84
65	4.801	2.56	4.801	2.49	4.801	2.48	4.801	4.37	4.801	2.81	4.801	2.87
66	4.876	2.56	4.876	2.50	4.876	2.49	4.876	4.42	4.876	2.81	4.876	2.89
67	4.951	2.56	4.951	2.49	4.951	2.49	4.951	4.43	4.951	2.81	4.951	2.90
68	5.026	2.58	5.026	2.51	5.026	2.48	5.026	4.51	5.026	2.83	5.026	2.86

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
68	5.026	2.58	5.026	2.51	5.026	2.48	5.026	4.51	5.026	2.83	5.026	2.86
69	5.101	2.66	5.101	2.51	5.101	2.48	5.101	4.64	5.101	2.83	5.101	2.90
70	5.176	2.68	5.176	2.50	5.176	2.48	5.176	4.63	5.176	2.84	5.176	2.87
71	5.251	2.68	5.251	2.50	5.251	2.48	5.251	4.62	5.251	2.85	5.251	2.86
72	5.326	2.68	5.326	2.55	5.326	2.49	5.326	4.67	5.326	2.84	5.326	2.90
73	5.401	2.66	5.401	2.55	5.401	2.49	5.401	4.71	5.401	2.84	5.401	2.89
74	5.476	2.65	5.476	2.56	5.476	2.50	5.476	4.73	5.476	2.85	5.476	2.87
75	5.551	2.66	5.551	2.52	5.551	2.54	5.551	4.84	5.551	2.86	5.551	2.86
76	5.626	2.68	5.626	2.54	5.626	2.53	5.626	4.91	5.626	2.87	5.626	3.12
77	5.701	2.90	5.701	2.54	5.701	2.52	5.701	4.98	5.701	2.86	5.701	2.94
78	5.776	2.89	5.776	2.53	5.776	2.52	5.776	4.99	5.776	2.87	5.776	2.96
79	5.851	2.90	5.851	2.53	5.851	2.52	5.851	4.98	5.851	2.88	5.851	3.02
80	5.926	2.98	5.926	2.54	5.926	2.52	5.926	5.03	5.926	2.89	5.926	2.94
81	6.002	2.94	6.002	2.53	6.002	2.52	6.002	5.09	6.002	2.89	6.002	2.92
82	6.077	3.38	6.077	2.53	6.077	2.52	6.077	5.12	6.077	2.90	6.077	2.92
83	6.152	3.41	6.152	2.53	6.152	2.52	6.152	5.18	6.152	2.91	6.152	2.91
84	6.227	3.09	6.227	2.54	6.227	2.53	6.227	5.24	6.227	2.96	6.227	2.90
85	6.302	3.04	6.302	2.57	6.302	2.52	6.302	5.28	6.302	2.92	6.302	2.93
86	6.377	3.15	6.377	2.55	6.377	2.52	6.377	5.39	6.377	2.93	6.377	2.93
87	6.452	3.17	6.452	2.57	6.452	2.53	6.452	5.36	6.452	2.93	6.452	2.93
88	6.527	3.10	6.527	2.56	6.527	2.54	6.527	5.38	6.527	2.95	6.527	2.93
89	6.602	3.10	6.602	2.55	6.602	2.55	6.602	5.40	6.602	2.99	6.602	2.93
90	6.677	3.16	6.677	2.57	6.677	2.57	6.677	5.39	6.677	2.96	6.677	2.93
91	6.752	3.21	6.752	2.60	6.752	2.54	6.752	5.38	6.752	2.98	6.752	2.99
92	6.827	3.31	6.827	2.57	6.827	2.53	6.827	5.41	6.827	2.98	6.827	2.99
93	6.902	3.32	6.902	2.56	6.902	2.53	6.902	5.42	6.902	3.00	6.902	3.17
94	6.977	3.38	6.977	2.58	6.977	2.55	6.977	5.49	6.977	2.99	6.977	3.03
95	7.052	3.36	7.052	2.57	7.052	2.56	7.052	5.50	7.052	2.98	7.052	2.99
96	7.127	3.29	7.127	2.57	7.127	2.55	7.127	5.52	7.127	2.99	7.127	2.98
97	7.202	3.31	7.202	2.58	7.202	2.55	7.202	5.56	7.202	3.02	7.202	3.01
98	7.277	3.59	7.277	2.58	7.277	2.56	7.277	5.57	7.277	3.01	7.277	3.00
99	7.352	3.48	7.352	2.61	7.352	2.57	7.352	5.61	7.352	3.03	7.352	2.99
100	7.427	3.57	7.427	2.61	7.427	2.59	7.427	5.62	7.427	3.08	7.427	3.40
101	7.502	3.48	7.502	2.60	7.502	2.57	7.502	5.62	7.502	3.05	7.502	3.13

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
68	5.026	2.58	5.026	2.51	5.026	2.48	5.026	4.51	5.026	2.83	5.026	2.86
69	5.101	2.66	5.101	2.51	5.101	2.48	5.101	4.64	5.101	2.83	5.101	2.90
70	5.176	2.68	5.176	2.50	5.176	2.48	5.176	4.63	5.176	2.84	5.176	2.87
71	5.251	2.68	5.251	2.50	5.251	2.48	5.251	4.62	5.251	2.85	5.251	2.86
72	5.326	2.68	5.326	2.55	5.326	2.49	5.326	4.67	5.326	2.84	5.326	2.90
73	5.401	2.66	5.401	2.55	5.401	2.49	5.401	4.71	5.401	2.84	5.401	2.89
74	5.476	2.65	5.476	2.56	5.476	2.50	5.476	4.73	5.476	2.85	5.476	2.87
75	5.551	2.66	5.551	2.52	5.551	2.54	5.551	4.84	5.551	2.86	5.551	2.86
76	5.626	2.68	5.626	2.54	5.626	2.53	5.626	4.91	5.626	2.87	5.626	3.12
77	5.701	2.90	5.701	2.54	5.701	2.52	5.701	4.98	5.701	2.86	5.701	2.94
78	5.776	2.89	5.776	2.53	5.776	2.52	5.776	4.99	5.776	2.87	5.776	2.96
79	5.851	2.90	5.851	2.53	5.851	2.52	5.851	4.98	5.851	2.88	5.851	3.02
80	5.926	2.98	5.926	2.54	5.926	2.52	5.926	5.03	5.926	2.89	5.926	2.94
81	6.002	2.94	6.002	2.53	6.002	2.52	6.002	5.09	6.002	2.89	6.002	2.92
82	6.077	3.38	6.077	2.53	6.077	2.52	6.077	5.12	6.077	2.90	6.077	2.92
83	6.152	3.41	6.152	2.53	6.152	2.52	6.152	5.18	6.152	2.91	6.152	2.91
84	6.227	3.09	6.227	2.54	6.227	2.53	6.227	5.24	6.227	2.96	6.227	2.90
85	6.302	3.04	6.302	2.57	6.302	2.52	6.302	5.28	6.302	2.92	6.302	2.93
86	6.377	3.15	6.377	2.55	6.377	2.52	6.377	5.39	6.377	2.93	6.377	2.93
87	6.452	3.17	6.452	2.57	6.452	2.53	6.452	5.36	6.452	2.93	6.452	2.93
88	6.527	3.10	6.527	2.56	6.527	2.54	6.527	5.38	6.527	2.95	6.527	2.93
89	6.602	3.10	6.602	2.55	6.602	2.55	6.602	5.40	6.602	2.99	6.602	2.93
90	6.677	3.16	6.677	2.57	6.677	2.57	6.677	5.39	6.677	2.96	6.677	2.93
91	6.752	3.21	6.752	2.60	6.752	2.54	6.752	5.38	6.752	2.98	6.752	2.99
92	6.827	3.31	6.827	2.57	6.827	2.53	6.827	5.41	6.827	2.98	6.827	2.99
93	6.902	3.32	6.902	2.56	6.902	2.53	6.902	5.42	6.902	3.00	6.902	3.17
94	6.977	3.38	6.977	2.58	6.977	2.55	6.977	5.49	6.977	2.99	6.977	3.03
95	7.052	3.36	7.052	2.57	7.052	2.56	7.052	5.50	7.052	2.98	7.052	2.99
96	7.127	3.29	7.127	2.57	7.127	2.55	7.127	5.52	7.127	2.99	7.127	2.98
97	7.202	3.31	7.202	2.58	7.202	2.55	7.202	5.56	7.202	3.02	7.202	3.01
98	7.277	3.59	7.277	2.58	7.277	2.56	7.277	5.57	7.277	3.01	7.277	3.00
99	7.352	3.48	7.352	2.61	7.352	2.57	7.352	5.61	7.352	3.03	7.352	2.99
100	7.427	3.57	7.427	2.61	7.427	2.59	7.427	5.62	7.427	3.08	7.427	3.40
101	7.502	3.48	7.502	2.60	7.502	2.57	7.502	5.62	7.502	3.05	7.502	3.13

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
102	7.577	3.56	7.577	2.64	7.577	2.57	7.577	5.65	7.577	3.05	7.577	3.19
103	7.652	3.52	7.652	2.63	7.652	2.61	7.652	5.67	7.652	3.13	7.652	3.24
104	7.727	3.65	7.727	2.62	7.727	2.60	7.727	5.67	7.727	3.08	7.727	3.23
105	7.802	4.02	7.802	2.62	7.802	2.59	7.802	5.67	7.802	3.08	7.802	3.19
106	7.877	5.90	7.877	2.61	7.877	2.63	7.877	5.67	7.877	3.15	7.877	3.14
107	7.952	5.92	7.952	2.63	7.952	2.66	7.952	5.68	7.952	3.12	7.952	3.14
108	8.027	5.94	8.027	2.63	8.027	2.63	8.027	5.69	8.027	3.12	8.027	3.10
109	8.102	5.98	8.102	2.62	8.102	2.63	8.102	5.69	8.102	3.13	8.102	3.13
110	8.177	10.30	8.177	2.65	8.177	2.63	8.177	5.70	8.177	3.14	8.177	3.33
111	8.252	10.33	8.252	2.67	8.252	2.64	8.252	5.72	8.252	3.17	8.252	3.20
112			8.327	2.66	8.327	2.63	8.327	5.89	8.327	3.17	8.327	3.19
113			8.402	2.67	8.402	2.62	8.402	5.88	8.402	3.17	8.402	3.17
114			8.477	2.67	8.477	2.65	8.477	5.89	8.477	3.21	8.477	3.15
115			8.552	2.69	8.552	2.65	8.552	5.92	8.552	3.20	8.552	3.19
116			8.627	2.67	8.627	2.66	8.627	5.94	8.627	3.36	8.627	3.17
117			8.702	2.77	8.702	2.66	8.702	5.91	8.702	3.44	8.702	3.19
118			8.777	2.84	8.777	2.68	8.777	5.89	8.777	3.31	8.777	3.32
119			8.852	2.71	8.852	2.67	8.852	5.90	8.852	3.33	8.852	3.38
120			8.927	2.71	8.927	2.66	8.927	5.89	8.927	3.37	8.927	3.40
121			9.002	2.69	9.002	2.68	9.002	5.95	9.002	3.37	9.002	3.36
122			9.077	2.71	9.077	2.68	9.077	5.97	9.077	3.36	9.077	3.29
123			9.152	2.81	9.152	2.68	9.152	5.97	9.152	3.40	9.152	3.46
124			9.227	2.71	9.227	2.68	9.227	5.95	9.227	3.39	9.227	3.37
125			9.302	2.80	9.302	2.69	9.302	5.99	9.302	3.52	9.302	3.33
126			9.377	2.72	9.377	2.76	9.377	6.01	9.377	3.53	9.377	3.42
127			9.452	2.76	9.452	2.71	9.452	6.02	9.452	3.50	9.452	3.40
128			9.527	2.75	9.527	2.71	9.527	6.02	9.527	3.55	9.527	3.50
129			9.602	2.79	9.602	2.68	9.602	6.01	9.602	3.55	9.602	3.43
130			9.677	2.78	9.677	2.67	9.677	6.03	9.677	3.61	9.677	3.40
131			9.752	2.77	9.752	2.72	9.752	6.05	9.752	3.73	9.752	3.82
132			9.827	2.76	9.827	2.70	9.827	6.05	9.827	3.91	9.827	3.65
133			9.902	2.78	9.902	2.69	9.902	6.05	9.902	4.01	9.902	3.58
134			9.977	2.77	9.977	2.69	9.977	6.05	9.977	3.97	9.977	3.67
135			10.053	2.82	10.053	2.70	10.053	6.11	10.053	3.95	10.053	3.63

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
135			10.053	2.82	10.053	2.70	10.053	6.11	10.053	3.95	10.053	3.63
136			10.128	2.81	10.128	2.72	10.128	6.11	10.128	4.04	10.128	3.66
137			10.203	2.86	10.203	2.76	10.203	6.11	10.203	4.11	10.203	3.71
138			10.278	2.84	10.278	2.76	10.278	6.11	10.278	4.17	10.278	3.74
139			10.353	2.83	10.353	2.77	10.353	6.18	10.353	4.25	10.353	3.76
140			10.428	2.86	10.428	2.81	10.428	6.20	10.428	4.31	10.428	3.78
141			10.503	3.07	10.503	2.79	10.503	6.23	10.503	4.54	10.503	3.77
142			10.578	2.90	10.578	2.95	10.578	6.22	10.578	4.59	10.578	3.81
143			10.653	2.89	10.653	2.87	10.653	6.30	10.653	4.65	10.653	3.88
144			10.728	2.92	10.728	2.84	10.728	6.26	10.728	4.70	10.728	3.97
145			10.803	2.91	10.803	3.16	10.803	6.53	10.803	4.74	10.803	4.09
146			10.878	2.96	10.878	3.01	10.878	6.51	10.878	4.82	10.878	4.15
147			10.953	2.96	10.953	2.98	10.953	6.41	10.953	4.86	10.953	4.18
148			11.028	3.05	11.028	2.96	11.028	6.34	11.028	4.92	11.028	4.30
149			11.103	3.05	11.103	2.96	11.103	6.34	11.103	4.95	11.103	4.37
150			11.178	2.99	11.178	2.94	11.178	6.33	11.178	4.98	11.178	4.49
151			11.253	2.98	11.253	2.92	11.253	6.34	11.253	5.02	11.253	4.58
152			11.328	3.29	11.328	2.97	11.328	6.33	11.328	5.05	11.328	4.70
153			11.403	3.19	11.403	2.96	11.403	6.32	11.403	5.08	11.403	4.76
154			11.478	3.25	11.478	2.96	11.478	6.32	11.478	5.12	11.478	4.82
155			11.553	3.05	11.553	2.96	11.553	6.34	11.553	5.17	11.553	4.85
156			11.628	3.06	11.628	2.96	11.628	6.34	11.628	5.19	11.628	4.94
157			11.703	3.07	11.703	2.96	11.703	6.35	11.703	5.22	11.703	4.98
158			11.778	3.11	11.778	3.36	11.778	6.36	11.778	5.28	11.778	5.01
159			11.853	3.07	11.853	3.18	11.853	6.36	11.853	5.30	11.853	5.03
160			11.928	3.13	11.928	3.05	11.928	6.47	11.928	5.33	11.928	5.04
161			12.003	3.06	12.003	3.00	12.003	6.45	12.003	5.35	12.003	5.07
162			12.078	3.15	12.078	2.96	12.078	6.44	12.078	5.39	12.078	5.11
163			12.153	3.38	12.153	2.98	12.153	6.45	12.153	5.41	12.153	5.15
164			12.228	3.45	12.228	3.03	12.228	6.44	12.228	5.42	12.228	5.17
165			12.303	3.55	12.303	3.06	12.303	6.45	12.303	5.43	12.303	5.27
166			12.378	3.39	12.378	3.05	12.378	6.46	12.378	5.46	12.378	5.31
167			12.453	3.60	12.453	3.01	12.453	6.47	12.453	5.49	12.453	5.34
168			12.528	3.65	12.528	3.46	12.528	6.47	12.528	5.52	12.528	5.35

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
169			12.603	3.51	12.603	3.22	12.603	6.54	12.603	5.57	12.603	5.38
170			12.678	3.38	12.678	3.11	12.678	6.55	12.678	5.60	12.678	5.41
171			12.753	3.91	12.753	3.22	12.753	6.56	12.753	5.61	12.753	5.43
172			12.828	3.71	12.828	3.22	12.828	6.71	12.828	5.65	12.828	5.45
173			12.903	3.46	12.903	3.18	12.903	6.73	12.903	5.65	12.903	5.45
174			12.978	3.51	12.978	3.30	12.978	6.71	12.978	5.66	12.978	5.45
175			13.053	3.55	13.053	3.68	13.053	6.68	13.053	5.66	13.053	5.47
176			13.128	3.69	13.128	3.45	13.128	6.66	13.128	5.68	13.128	5.49
177			13.203	3.74	13.203	3.41	13.203	6.65	13.203	5.71	13.203	5.51
178			13.278	3.90	13.278	3.45	13.278	6.64	13.278	5.72	13.278	5.53
179			13.353	3.90	13.353	3.46	13.353	6.75	13.353	5.72	13.353	5.57
180			13.428	3.83	13.428	3.63	13.428	6.82	13.428	5.75	13.428	5.60
181			13.503	4.20	13.503	3.76	13.503	6.93	13.503	5.80	13.503	5.61
182			13.578	4.44	13.578	3.75	13.578	6.89	13.578	5.79	13.578	5.61
183			13.653	4.67	13.653	3.62	13.653	6.90	13.653	5.78	13.653	5.62
184			13.728	5.09	13.728	3.63	13.728	6.88	13.728	5.78	13.728	5.63
185			13.803	5.44	13.803	3.65	13.803	6.87	13.803	5.79	13.803	5.64
186			13.878	5.51	13.878	3.75	13.878	6.93	13.878	5.80	13.878	5.65
187			13.953	5.62	13.953	3.89	13.953	6.92	13.953	5.80	13.953	5.71
188			14.029	5.80	14.029	4.06	14.029	6.96	14.029	5.81	14.029	5.74
189			14.104	6.35	14.104	4.24	14.104	6.92	14.104	5.84	14.104	5.73
190			14.179	6.61	14.179	4.52	14.179	6.90	14.179	5.85	14.179	5.74
191			14.254	6.82	14.254	5.38	14.254	6.87	14.254	5.86	14.254	5.75
192			14.329	6.95	14.329	5.82	14.329	6.85	14.329	5.88	14.329	5.77
193			14.404	7.19	14.404	5.91	14.404	6.85	14.404	5.92	14.404	5.78
194			14.479	7.32	14.479	6.29	14.479	6.84	14.479	6.01	14.479	5.79
195			14.554	7.40	14.554	7.00	14.554	6.86	14.554	5.94	14.554	5.82
196			14.629	7.53	14.629	7.18	14.629	6.89	14.629	5.94	14.629	5.88
197			14.704	7.69	14.704	7.31	14.704	6.95	14.704	5.95	14.704	5.88
198			14.779	7.77	14.779	7.53	14.779	6.95	14.779	5.96	14.779	5.88
199			14.854	8.18	14.854	7.74	14.854	6.99	14.854	5.97	14.854	5.88
200			14.929	8.31	14.929	7.91	14.929	7.08	14.929	6.02	14.929	5.88
201			15.004	8.52	15.004	8.01	15.004	7.13	15.004	6.02	15.004	5.89
202			15.079	8.73	15.079	8.36	15.079	7.21	15.079	6.05	15.079	5.90

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
200			14.929	8.31	14.929	7.91	14.929	7.08	14.929	6.02	14.929	5.88
201			15.004	8.52	15.004	8.01	15.004	7.13	15.004	6.02	15.004	5.89
202			15.079	8.73	15.079	8.36	15.079	7.21	15.079	6.05	15.079	5.90
203			15.154	8.87	15.154	8.87	15.154	7.26	15.154	6.06	15.154	5.93
204			15.229	9.03	15.229	9.04	15.229	7.28	15.229	6.07	15.229	5.94
205			15.304	9.21	15.304	9.11	15.304	7.27	15.304	6.07	15.304	5.95
206			15.379	9.35	15.379	9.18	15.379	7.26	15.379	6.09	15.379	5.95
207			15.454	9.47	15.454	9.25	15.454	7.25	15.454	6.09	15.454	5.97
208			15.529	9.62	15.529	9.50	15.529	7.26	15.529	6.11	15.529	5.99
209			15.604	9.74	15.604	9.58	15.604	7.28	15.604	6.11	15.604	6.00
210			15.679	9.97	15.679	9.64	15.679	7.35	15.679	6.11	15.679	6.11
211			15.754	10.27	15.754	9.68	15.754	7.40	15.754	6.17	15.754	6.14
212			15.829	10.41	15.829	9.73	15.829	7.44	15.829	6.17	15.829	6.12
213			15.904	10.50	15.904	9.83	15.904	7.47	15.904	6.17	15.904	6.11
214			15.979	10.56	15.979	9.88	15.979	7.49	15.979	6.20	15.979	6.09
215			16.054	10.61	16.054	9.93	16.054	7.52	16.054	6.24	16.054	6.09
216			16.129	10.71	16.129	10.36	16.129	7.59	16.129	6.23	16.129	6.09
217			16.204	10.77	16.204	10.46	16.204	7.65	16.204	6.22	16.204	6.10
218			16.279	10.85	16.279	10.48	16.279	7.77	16.279	6.22	16.279	6.11
219			16.354	10.90	16.354	10.50	16.354	7.87	16.354	6.24	16.354	6.11
220			16.429	10.95	16.429	10.52	16.429	8.01	16.429	6.25	16.429	6.12
221					16.504	10.54	16.504	8.07	16.504	6.30	16.504	6.12
222					16.579	11.00	16.579	8.24	16.579	6.30	16.579	6.12
223					16.654	11.13	16.654	8.39	16.654	6.31	16.654	6.14
224					16.729	11.19	16.729	8.48	16.729	6.32	16.729	6.16
225					16.804	11.22	16.804	8.62	16.804	6.32	16.804	6.20
226					16.879	11.25	16.879	8.72	16.879	6.32	16.879	6.22
227					16.954	11.27	16.954	8.84	16.954	6.34	16.954	6.21
228					17.029	11.28	17.029	8.98	17.029	6.37	17.029	6.21
229					17.104	11.29	17.104	9.07	17.104	6.43	17.104	6.21
230					17.179	11.32	17.179	9.15	17.179	6.44	17.179	6.26
231					17.254	11.32	17.254	9.27	17.254	6.41	17.254	6.34
232					17.329	11.33	17.329	9.36	17.329	6.43	17.329	6.33

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
231					17.254	11.32	17.254	9.27	17.254	6.41	17.254	6.34
232					17.329	11.33	17.329	9.36	17.329	6.43	17.329	6.33
233					17.404	11.36	17.404	9.61	17.404	6.42	17.404	6.34
234							17.479	9.79	17.479	6.43	17.479	6.34
235							17.554	9.91	17.554	6.43	17.554	6.33
236							17.629	10.02	17.629	6.44	17.629	6.34
237							17.704	10.17	17.704	6.45	17.704	6.34
238							17.779	10.37	17.779	6.46	17.779	6.34
239							17.854	10.46	17.854	6.48	17.854	6.34
240							17.929	10.52	17.929	6.49	17.929	6.36
241							18.005	10.56	18.005	6.55	18.005	6.36
242							18.080	10.62	18.080	6.60	18.080	6.42
243							18.155	10.65	18.155	6.62	18.155	6.44
244							18.230	10.69	18.230	6.60	18.230	6.44
245							18.305	10.72	18.305	6.59	18.305	6.43
246							18.380	10.79	18.380	6.60	18.380	6.45
247							18.455	10.82	18.455	6.60	18.455	6.46
248							18.530	10.89	18.530	6.61	18.530	6.46
249							18.605	10.92	18.605	6.62	18.605	6.47
250							18.680	10.93	18.680	6.64	18.680	6.47
251							18.755	10.96	18.755	6.65	18.755	6.48
252							18.830	10.96	18.830	6.72	18.830	6.49
253							18.905	10.99	18.905	6.79	18.905	6.50
254									18.980	6.82	18.980	6.51
255									19.055	6.83	19.055	6.51
256									19.130	6.82	19.130	6.51
257									19.205	6.80	19.205	6.51
258									19.280	6.85	19.280	6.51
259									19.355	6.89	19.355	6.51
260									19.430	6.94	19.430	6.51
261									19.505	7.00	19.505	6.55
262									19.580	6.98	19.580	6.66
263									19.655	7.01	19.655	6.66
264									19.730	7.02	19.730	6.67

No device connected.

	Run 1		Run 2		Run 3		Run 4		Run 5		Run 6	
	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH	Volume (mL)	pH
264									19.730	7.02	19.730	6.67
265									19.805	7.01	19.805	6.68
266									19.880	7.01	19.880	6.71
267									19.955	7.02	19.955	6.71
268									20.030	7.05	20.030	6.73
269									20.105	7.08	20.105	6.74
270									20.180	7.08	20.180	6.77
271									20.255	7.09	20.255	6.78
272									20.330	7.12	20.330	6.79
273									20.405	7.17	20.405	6.80
274									20.480	7.19	20.480	6.82
275									20.555	7.20	20.555	6.83
276									20.630	7.23	20.630	6.94
277									20.705	7.26	20.705	6.95
278									20.780	7.36	20.780	6.96
279									20.855	7.43	20.855	6.97
280									20.930	7.47	20.930	6.97
281									21.005	7.53	21.005	6.97
282									21.080	7.57	21.080	6.99
283									21.155	7.65	21.155	7.01
284									21.230	7.73	21.230	7.03
285									21.305	7.90	21.305	7.05
286									21.380	7.98	21.380	7.07
287									21.455	8.04	21.455	7.09
288									21.530	8.11	21.530	7.11
289									21.605	8.20	21.605	7.16
290									21.680	8.30	21.680	7.19
291									21.755	8.42	21.755	7.26
292									21.830	8.69	21.830	7.38
293									21.905	8.82	21.905	7.40
294									21.980	9.04	21.980	7.43
295									22.056	9.17	22.056	7.49
296									22.131	9.29	22.131	7.52
297									22.206	9.40	22.206	7.54



## **Observations**

### Part 1:

*Trial 1:* After adding the indicator, the Phenolphthalein, to the acid, HCl, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 11.20 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

*Trial 2:* After adding the indicator, the Phenolphthalein, to the acid, HCl, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 12.10 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

*Trial 3:* After adding the indicator, the Phenolphthalein, to the acid, HCl, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 14.79 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

### Part 2:

*Trial 1:* By adding the indicator, the Phenolphthalein, to acid #3, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 18.755 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

*Trial 2:* By adding the indicator, the Phenolphthalein, to acid #3, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 21.38 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

*Trial 3:* By adding the indicator, the Phenolphthalein, to acid #3, nothing changes, thus the solution remains clear and transparent. The same result was produced out of the mixture of NaOH and the distilled water. After adding 22.206 mL of the base to the acidic solution, the liquid turned dark pink and remained transparent.

### **Calculations**

1. *Determining the initial concentration of the NaOH*

$$C_2(0.2441\text{L}) = (6\text{M})(0.0041\text{L})$$

$$C_2 = 0.1008\text{M}$$

2. *Finding the bases concentration,  $C_{\text{base}}V_{\text{base}} = C_{\text{acid}}V_{\text{acid}}$*

#### Part 1

$$\text{Trial 1: } C_{\text{base}} = \frac{0.100 \times 9.98}{11.2} = 0.0891 \text{ M}$$

$$\text{Trial 2: } C_{\text{base}} = \frac{0.100 \times 10.65}{12.1} = 0.880 \text{ M}$$

$$\text{Trial 3: } C_{\text{base}} = \frac{0.100 \times 10.45}{14.79} = 0.0706 \text{ M}$$

$$\text{Average: } \frac{0.0891 + 0.880 + 0.0706}{3} = 0.346 \text{ M}$$

\*Please refer to the graphs in Appendix A\*

### 3. Finding the concentration for acid #3, $C_{base} \cdot V_{base} = b/a \cdot C_{acid} \cdot V_{acid}$

#### Part 2

$$\text{Trial 1: } C_{acid} = \frac{0.346 \cdot 18.755}{0.5 \cdot 9.85} = 1.312 \text{ M}$$

$$\text{Trial 2: } C_{acid} = \frac{0.346 \cdot 21.38}{0.5 \cdot 9.02} = 1.640 \text{ M}$$

$$\text{Trial 3: } C_{acid} = \frac{0.346 \cdot 22.206}{0.5 \cdot 10.24} = 1.501 \text{ M}$$

$$\text{Average} = \frac{1.312 + 1.640 + 1.501}{3} = 1.484 \text{ M}$$

\*Please refer to the graphs in Appendix A\*

#### **Discussion**

When producing the mixture of NaOH with distilled water, the volume of concentrated NaOH used does matter. In depth, if we add a significant amount of the base to the distilled water, the solution will contain a higher concentration of NaOH whereas if we do not add as much, the solution will be less concentrated in NaOH. This can have an effect on the amount of drops needed to find the equivalence and end point of the acidic solution. If it is highly concentrated, it will take less drops to obtain our goal and if it less concentrated it will take more. Next, it is better to take record the concentration of the NaOH moments before conducting the experiment since it is a very dense substance. Hence, a precise measurement of the concentration can improve the results significantly. In the graph, *pH vs. Volume - Trial 1*, with the calculated column, it is very easy to see that the drop counter was not functioning at the time we started adding the base solution to the acid. This is why the results for this one were not as precise. On top of that, Many other source of errors could have affected the outcome of this experiment such as, miscalculations, not well calibrating the drop counter and lack of precise measurements. There is also possibility that the beakers were not properly clean which means other substances could've contaminated our own.

## **Conclusion**

In conclusion, the concentration of the NaOH is 0.346 M and the concentration of the unknown acid, #3, is 1.484 M.

## **References**

Dr. Rashmi Venkateswran (2018). Lab Manual "Acid Base Titrations", Experiment 4.

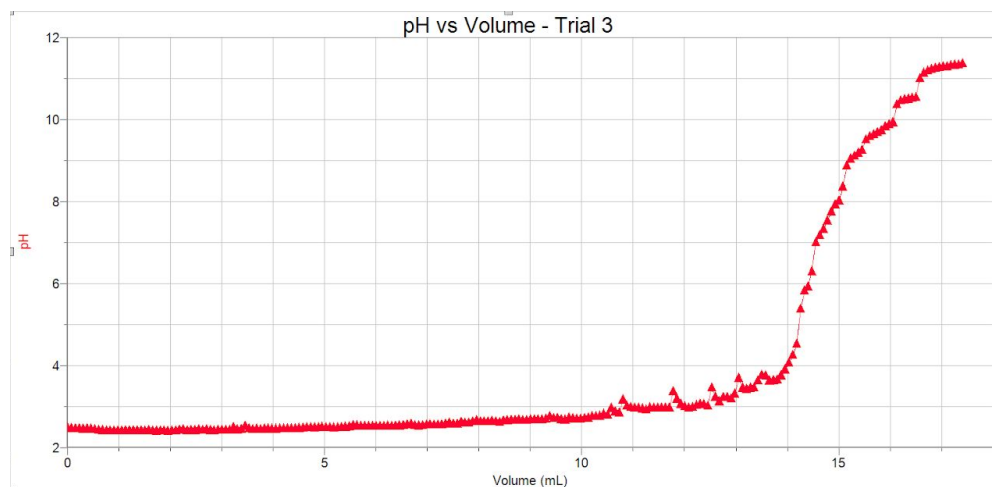
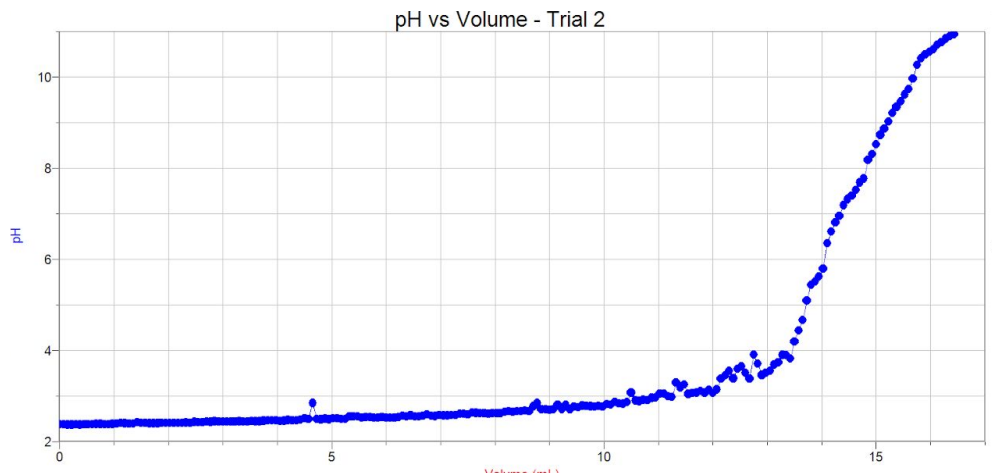
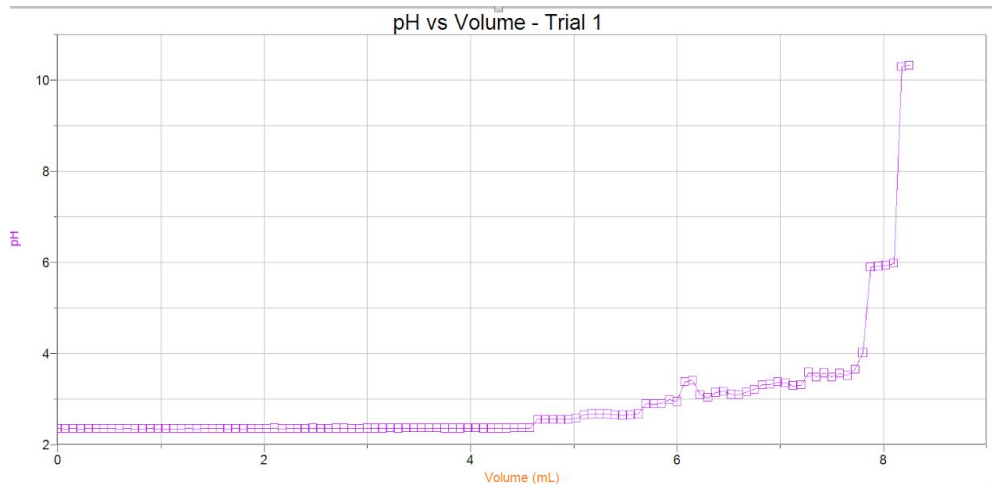
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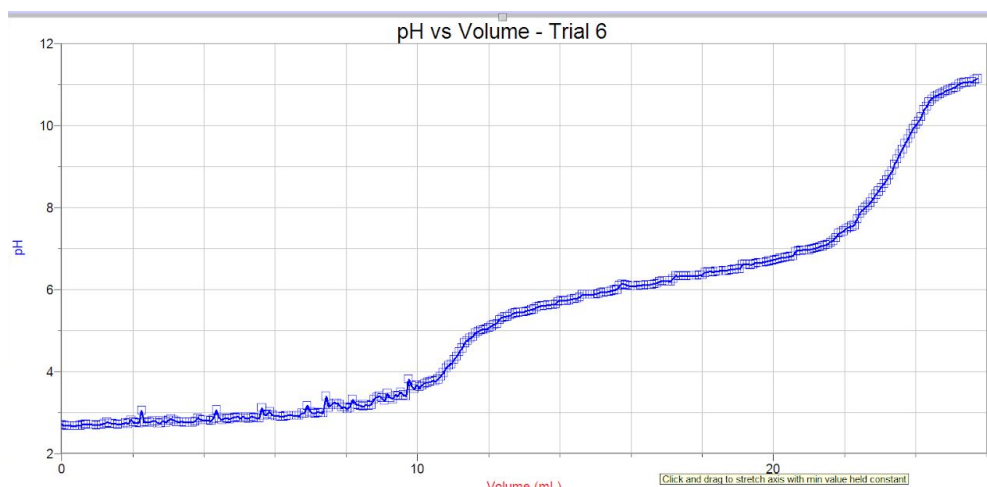
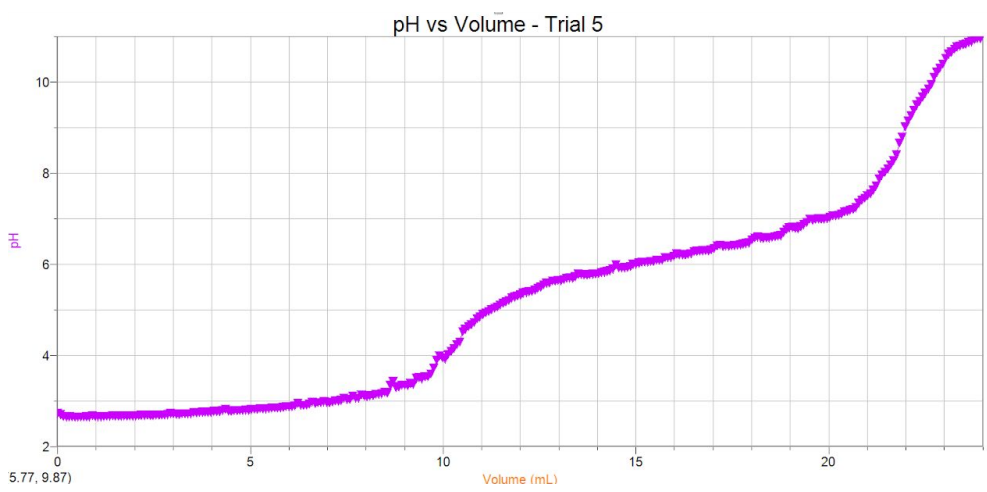
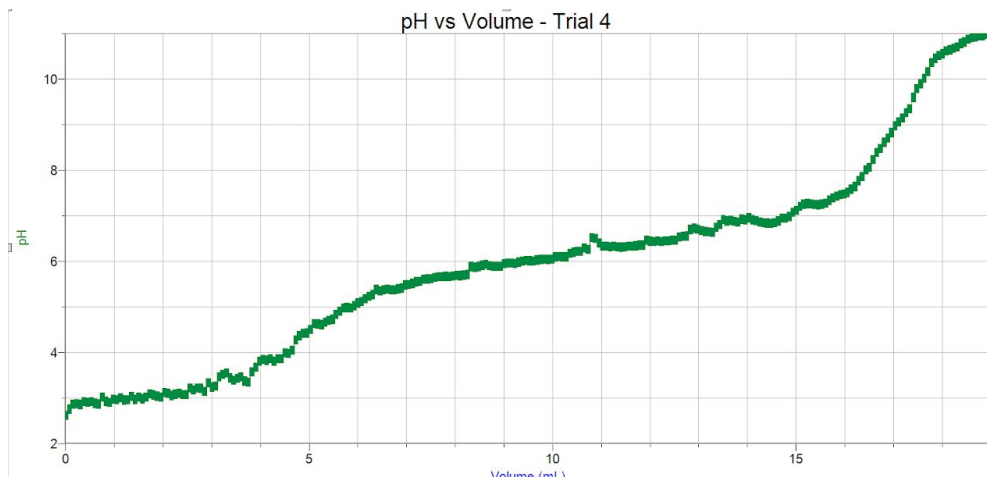
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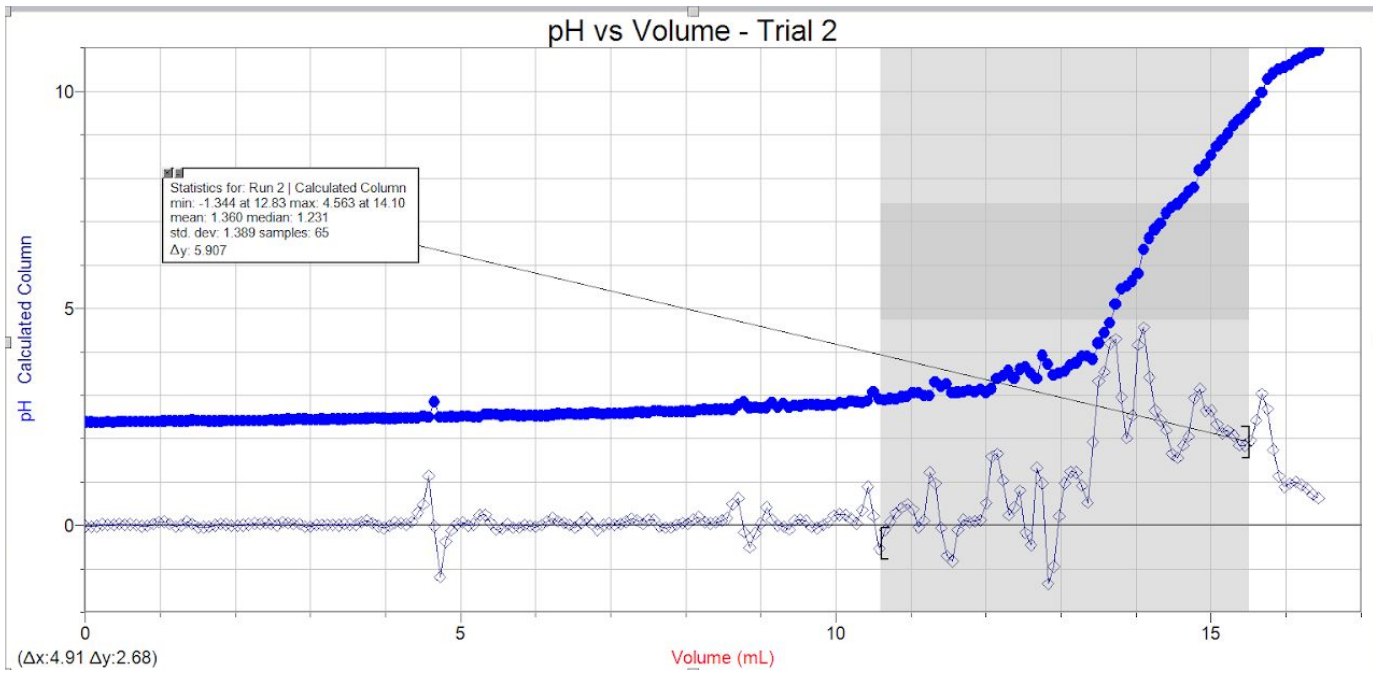
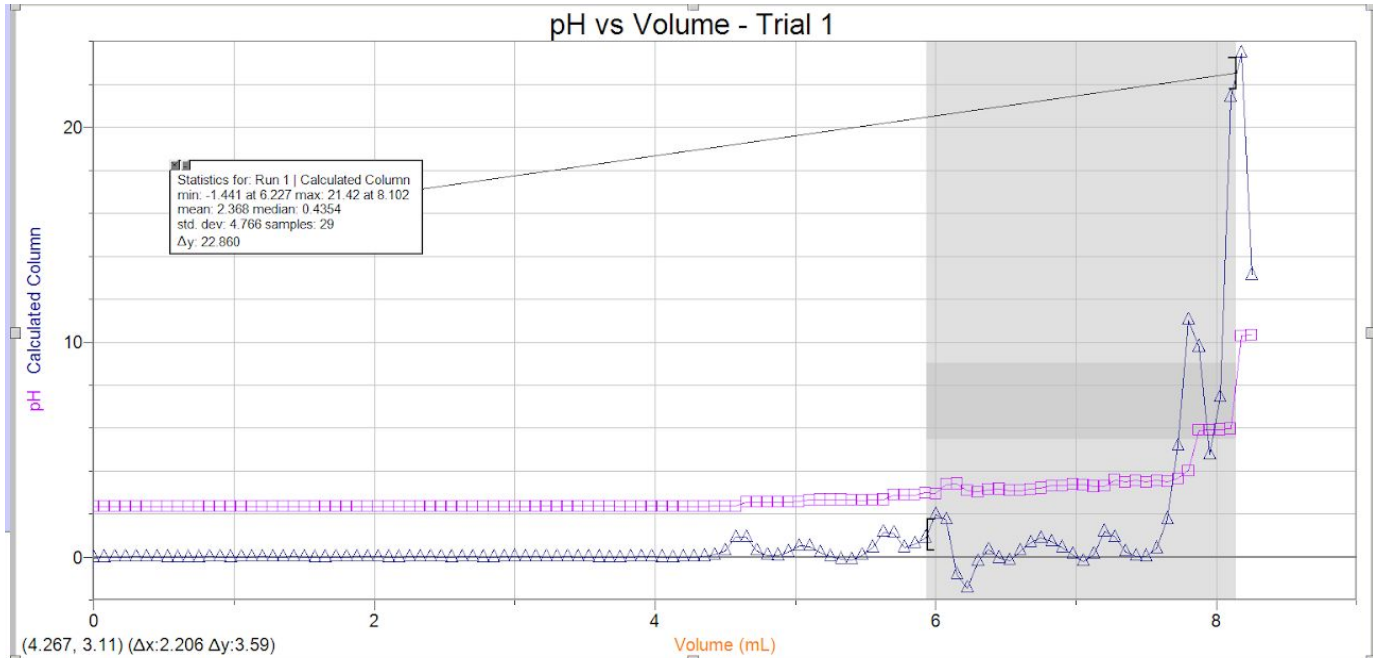
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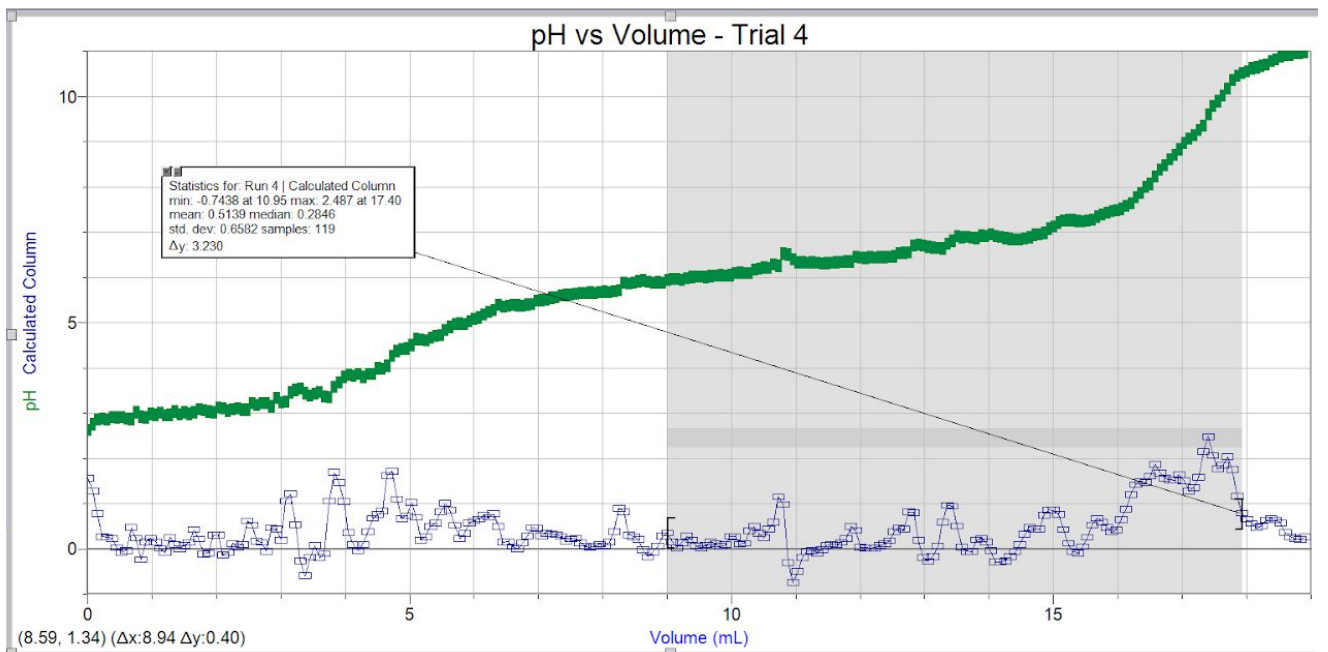
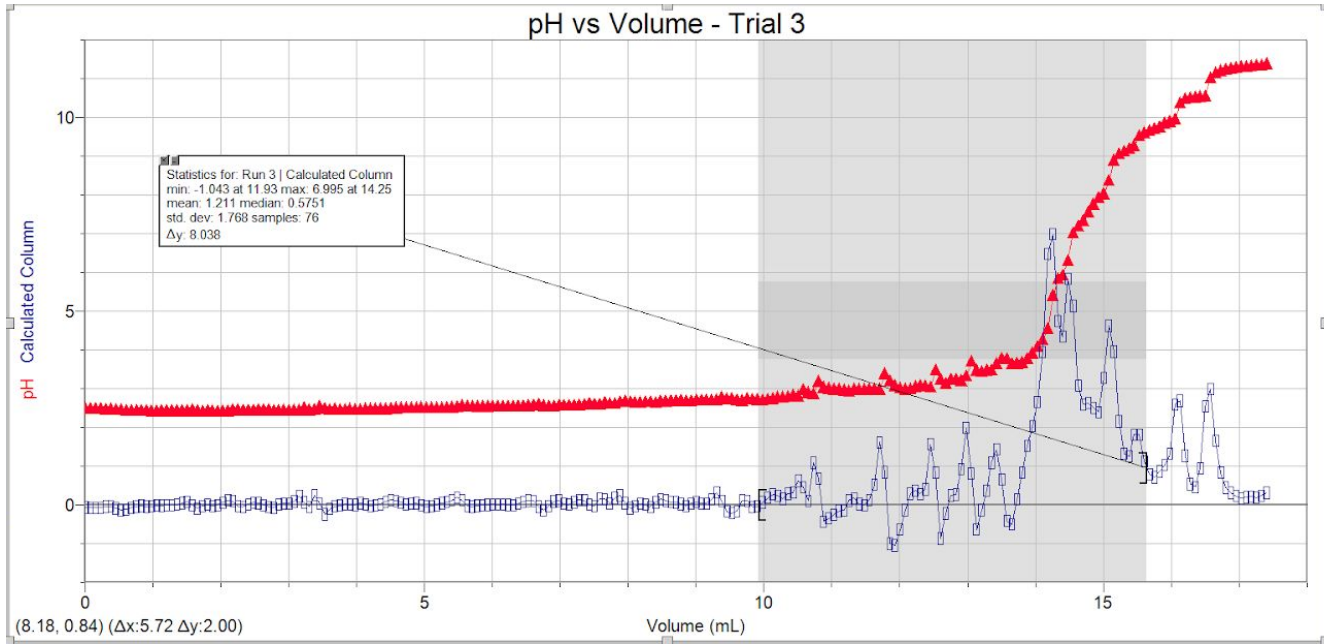
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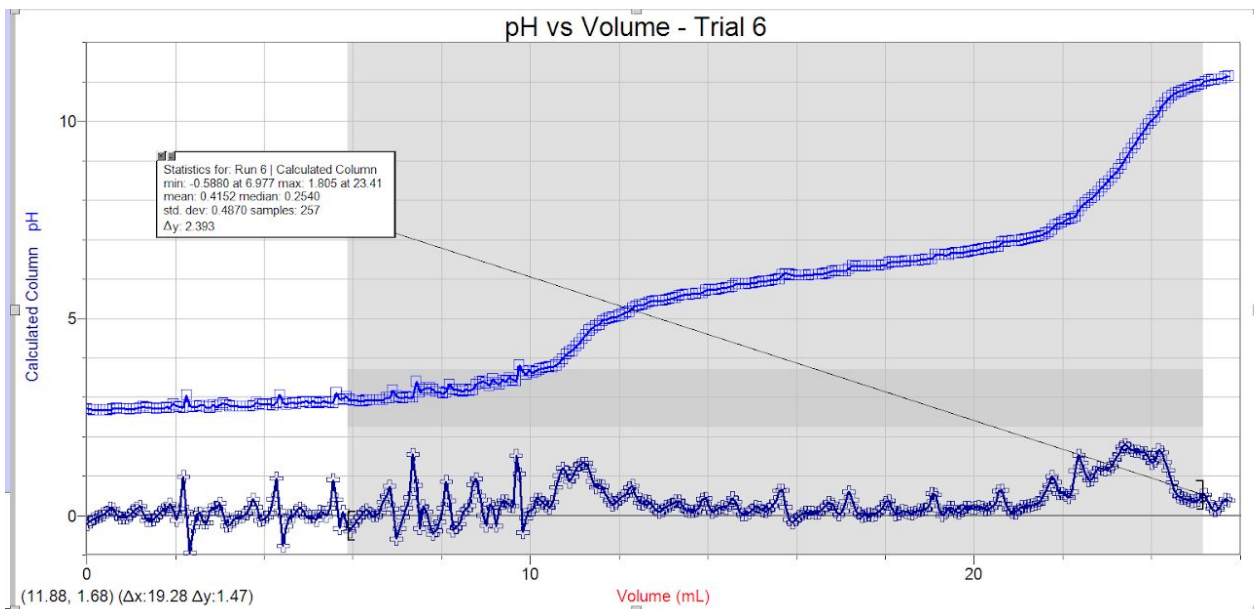
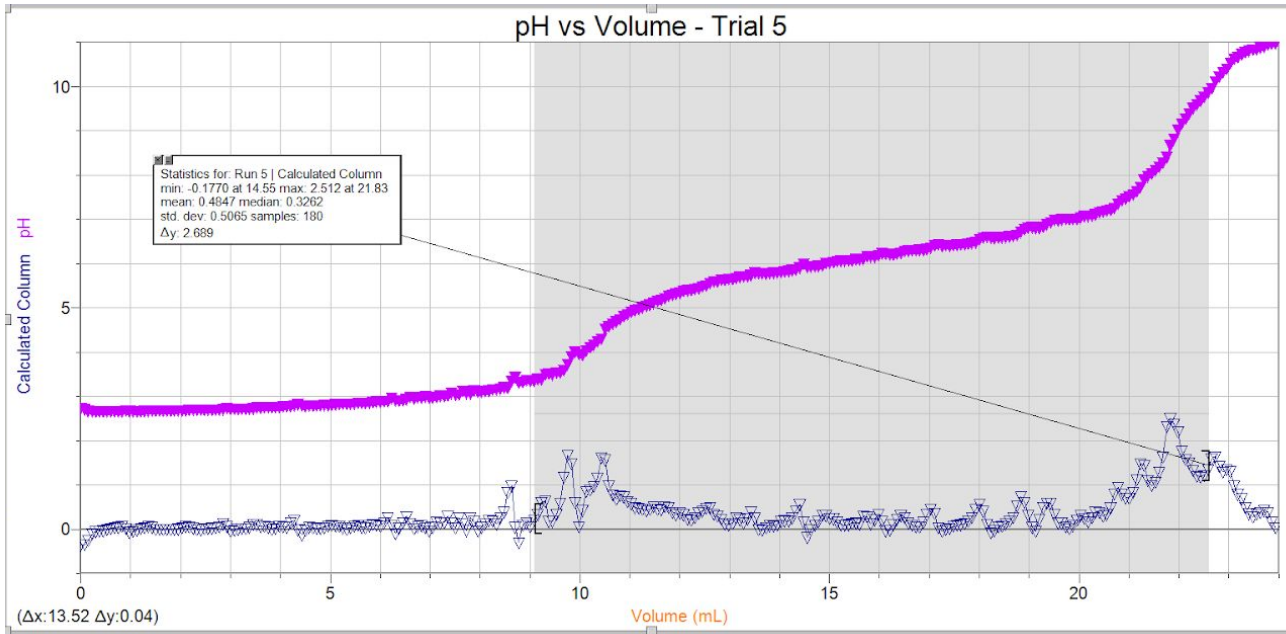
# Appendix A











## Experiment 4

### Starting...

1. Grab 10mL of NaOH
2. put 245 mL of distilled water inside dry 400mL beaker
3. Add NaOH, while stirring (2mins)
4. Pour the rest in waste container

### Drop Counter...

5. Connect lab quest 2 with Drop counter
6. Clamp it inside the beaker
7. Fill buret to 40 mL mark with diluted NaOH
8. Ensure NaOH is dropping at a rate of 1-2 drops/sec
9. add 2-3mL of the NaOH to the 10mL graduated cylinder, note volume
10. Calibrate Drop Counter
11. Note final volume and # of drops

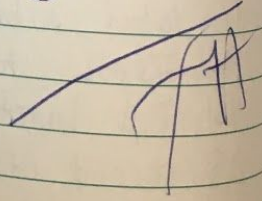
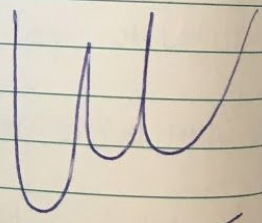
### Standardizing the diluted NaOH solution...

12. label a buret "acid", attach using clamp
13. 50mL to get 25mL of Monoprotic acid
14. fill buret with acid
15. record original reading and transfer 10mL of the acid into 150mL beaker, note exact + final readings
16. add 2-3 drops of phenolphthalein and magnetic stir bar
17. Place beaker on the stir plate
18. Connect pH probe to lab quest, rinse with distilled water
19. pass through hole in drop counter

20. refill buret with NaOH at 40ml mark
21. graph pH in function with the volume
22. open bottom tap to let out 1-2 drops/sec
23. Note volume of added base, plus new colour
24. Stop run when pH has risen/leveled off at about
25. Save to USB
26. Fill plastic buret to the 30ml mark, delete NaOH

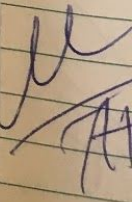
Determining Concentration of unknown acid

27. Empty the glass buret and rinse
  28. use 50ml beaker to obtain 25ml of unknown diprotic acid (record #)
  29. Fill clean beaker with unknown acid
  30. repeat titration steps
- Save.



St  
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acid 3

### Lab 4

$V_{\text{acid}} = 24 \text{ mL}$     $V_{\text{NaOH}} = 4.1 \text{ mL}$

~~Step 12  $\rightarrow$  2.4 mL NaOH in Graduate cylinder~~

Step 12  $\rightarrow$  <sup>2.8</sup>2.4 mL NaOH in Graduate cylinder

Final volume = 4.6 mL with 24 drops  
 $\rightarrow 4.6 - 2.8 = 1.8 \text{ mL}$

Volume of HCl in buret  $\rightarrow$  24.2 mL

Standardizing Diluted NaOH solution

Run 1

Volume in buret = 24.2 - 9.98 = 14.22 mL

Volume of acid transferred = 9.98 mL

4 drops of phenolphthalein were added to the acid

~~100~~ added 110 mL of distilled water + 9.98 mL of HCl

~~100~~

change colour (pink) when 11 mL of base (NaOH) was added

$\rightarrow$  Run was stopped when pH was 10.96.

Run 2

Volume in buret =

Volume of acid transferred = 10.32 mL of HCl

3 drops of indicator added

Volume of distilled water = 109.7 mL

Plastic buret = 39.0 mL

Colour changed to pink when ~~12.1~~ 12.1 mL of base was added

Run 3  
Volume of acid  $\rightarrow$  10.45 mL  
4 drops of indicator were added  
Volume water added  $\rightarrow$  109.55 mL  
Volume plastic buret  $\rightarrow$  41 mL  
Change colour to pink when ~~volume~~ 14.179 mL of  
was added  
pH = 11.03 at volume 16.729 mL

Determining the concentration of unknown

Run 4 Using acid #3...

Volume of acid  $\rightarrow$  9.85 mL  
3 drops of indicator was added  
Volume water added  $\rightarrow$  110.15 mL  
Volume plastic buret  $\rightarrow$  42 mL  
Change colour to pink when 16.654 mL of NaOH  
pH = 10.98 at volume = 18.755

Run 5

Volume of acid  $\rightarrow$  9.02 mL  
3 drops of indicator  
Volume of water added  $\rightarrow$  110.98 mL  
Volume of ~~real~~ NaOH in plastic  $\rightarrow$  40.5 mL  
change to pink when 21.38 mL of NaOH added  
pH = 11  
Volume = 23.78 mL

[run b] ~~11/16~~

Volume of acid added  $\rightarrow$  10.24 mL

3 drops of indicator

Volume of water added  $\rightarrow$  109.76 mL

Colour change to pink when 22.20 mL of NaOH

pH = 11.28      Volume = 25 mL

W  
TH

1.79 mL of base

unknown acid

1 mL of NaOH

8 mL  
10.5 mL  
NaOH added

