

Potentiometric titration of sodium carbonate



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Potentiometric Titration of Sodium Carbonate Otieno O. Victor University of Detroit Mercy Quantitative Analysis Lab CHM 3880 Fall 2011 Partner: Edwin Gay Abstract The PH at each point during the titration of sodium carbonate unknown sample was determined. An Unknown sample of Na_2CO_3 was titrated with a standard HCL solution. In addition to titration, the pH at each point of titration was measured using PH meter. The % of the unknown Na_2CO_3 was 25. 83% Introduction¹ The purpose of this experiment was to determine the actual pH at each point during the titration of a sodium carbonate unknown with the use of pH meter. An acid-base titration is a procedure which is used to determine the concentration of an acid or base. A measured volume of an acid or base of known concentration is reacted with a sample to the equivalence point. However, there are difficulties in completing acid-base reactions with the aid of visual indicators. This is likely due to factors like unsuitable color change for a given type of titration. Also, this might be due to student's being color-blind to certain indicator color changes. Moreover, certain solutions might be already be colored. To limit such uncertainties and difficulties, potentiometric titration is applicable. Potentiometric titration can be used to distinguish acids. The amount of titrant added helps determines the pH of a solution. Usually, a change in pH observed is small. However, at endpoint, the pH observed is often of a sharp change. The sharpness of the change is reflective of the strength of the acid or base. To determine the end point, all the point is graphed and then location of a sudden change in pH determined. The equations used were: Equation: $\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{H}^+ + \text{NaCO}_3^-$ for first equivalence point reaction. Equation 2: $\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{H}^+ + \text{NaCO}_3$ for second equivalence point reaction Experimental procedure¹ In standardization of HCL, a dried <https://assignbuster.com/potentiometric-titration-of-sodium-carbonate/>

and cooled Na_2CO_3 was placed in a weighing bottle. Then, 3 samples of primary standard Na_2CO_3 were weighed in 125 mL Erlenmeyer flask. The masses were 0.1833g, 0.1835g, and 0.1834g. Then, 50mL of distilled water was added to each flask. Then, 3 drops of phenolphthalein indicator was added to each flask. Then, 50mL burette was filled with standard HCl solution. The solutions in each were titrated to phenolphthalein end point. Then, 3 drops of bromo-cresol green indicator was added. Then, titration was continued until bromo-cresol green indicator begun to turn green. The solutions were then boiled for 10 minutes and titrated to bromo-cresol green end point. In titration of unknown, a sample of 0.3959g was weighed, placed in 250-mL beaker and 50mL of distilled water added to the beaker by pipette. The solution was then stirred with glass rode. The PH meter was standardized with 2 buffer solutions. The electrodes were washed and gently wiped with soft tissue. The electrodes were immersed in the solution and left immersed for the entire period of titration. The starting PH was recorded. A burette was filled with the standard HCl solution and starting volume noted. About 1.0mL of HCL was added to the solution and thoroughly stirred and PH recorded. The titrant addition was continued at about 1.0mL at a time. The PH and volume changes were recorded. At about 1.0-1.5mL of first equivalence, the titrant was added in an increment of 0.2mL. The burette and the PH were recorded. However, me and my lab partner forgot to boil the solution when we were about 1.0 of second equivalence point. We continued with the titration with small increment of titrant until about 1.0-2.0mL beyond second equivalence point. Then, the electrodes were removed and rinsed thoroughly and then re-immersed in distilled water. Results The table1 shows the titration results for the known mass of Na_2CO_3 Table1:

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titration results

Trial #	Mass of Na ₂ CO ₃ (g)	Volume of 1st equivalence(mL)	Volume of 2nd equivalence(mL)	Last amount to 2nd equivalence (mL)	Total volume, V _e (mL)	HCl(M)
1	0.1833	17.40	34.50	1.70	36.20	0.09555
2	0.1835	18.00	35.00	1.20	36.20	0.09565
3	0.1834	19.20	35.25	1.00	36.25	0.0954
mean						
	0.09556	+/-0.000090				

Table2 shows the titration results and the Ph of the measured of the unknown mass of Na₂CO₃ while Graph1 shows the plot obtained from a graph of PH against the volume of HCL used in titration. On the other hand, table3 denotes the data of Volume of HCL and first derivative equivalence volume while table 4 shows the data of Volume of HCL and first derivative equivalence volume. Graph2 gives the first derivative plot while graph 3 gives the second derivative plot. The first derivative V_e column is the slope determined by subtracting a value at top of pH from pH value below it and dividing the quantity by subtracting a volume from another. The same procedure was also done for the second derivative V_e. However, instead of pH, the first derivatives of V_e values were used as well as the volume of HCL.

Volume of titration	PH	Volume(mL)	pH
0.00	10.83	23.00	2.91
1.00	10.66	23.20	2.83
2.00	10.47	23.50	2.69
3.00	10.35	23.80	2.61
4.00	10.18	24.00	2.54
5.00	10.01	24.50	2.49
6.00	9.88	7.00	9.76
8.00	9.59	9.00	9.41
10.00	9.15	10.30	9.05
10.50	8.88		
10.90	8.74	11.20	8.64
11.50	8.58	11.80	8.00
12.00	7.77		
12.30	7.48	12.60	7.27
12.90	7.15	14.00	6.85
15.00	6.62		
16.00	6.5	17.00	6.33
18.00	6.18	19.00	5.98
19.50	5.88		
20.00	5.74	20.50	5.64
21.00	5.5	21.50	5.23
21.70	5.14		
22.00	4.76	22.20	4.51
22.40	3.81	22.55	3.4
22.80	3.13		

Graph1: pH vs. mL HCL Table3: Volume of HCL and first derivative

equivalence volume	Vol NaOH (mL)	1st deriv Ve (mL)	Vol NaOH (mL)	1st deriv Ve (mL)
0.5	-0.17	22.9	-1.1	1.5
-0.19	23.1	-0.4	2.5	-0.12
23.35	-0.466666667	3.5	-0.17	23.65
-0.266666667	4.5	-0.17	23.9	-0.35
5.5	-0.13	24.25	-0.1	6.5
-0.12	7.5	-0.17	8.5	-0.18
9.5	-0.26	10.15	-0.333333333	10.4
-0.85	10.7	-0.35	11.05	-0.333333333
11.35	-0.2	11.65	-1.933333333	11.9
-1.15	12.15	-0.966666667	12.45	-0.7
12.75	-0.4	13.45	-0.272727273	14.5
-0.23	15.5	-0.12	16.5	-0.17
17.5	-0.15	18.5	-0.2	19.25
-0.2	19.75	-0.28	20.25	-0.2
20.75	-0.28	21.25	-0.54	21.6
-0.45	21.85	-1.266666667	22.1	-1.25
22.3	-3.5	22.475	-2.733333333	22.675
-1.08	Graph2: The first derivative plot.			

Table4: Volume of HCL and second derivative equivalence volume Vol NaOH

(mL)	2nd deriv Ve (mL)	Vol NaOH (mL)	2nd deriv Ve (mL)
1	-0.02	23	3.5
2	0.07	23.225	-0.266666667
3	-0.05	23.5	0.666666667
4	0	23.775	-0.333333333
5	0.04	24.075	0.714285714
6	0.01	7	-0.05
8	-0.01	9	-0.08
9.825	-0.112820513	10.275	-2.066666667
10.55	1.666666667	10.875	0.047619048
11.2	0.444444444	11.5	-5.777777778
11.775	3.133333333	12.025	0.733333333
12.3	0.888888889	12.6	1
13.1	0.181818182	13.975	0.040692641
15	0.11	16	-0.05
17	0.02	18	-0.05
18.875	-2.36848E-15	19.5	-0.16
20	0.16	20.5	-0.16
21	-0.52	21.425	0.257142857
21.725	-3.266666667	21.975	0.066666667
22.2	-11.25	22.3875	4.380952381
22.575	8.266666667	22.7875	-0.088888889

Graph: The second derivative plot. The % of unknown Na₂CO₃ was determined from division mass of Na₂CO₃: 0.1129g obtained from

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calculation from second equivalence point with the mass of the unknown: 0.3959g. It was 28.53% Discussion The experiment was a success. This is because the actual pH at each point during titration of Na_2CO_3 unknown was able to be determined. This was a little challenging because it required the utmost patience in adding the volume of the titrant. However, in the procedure section, there was a requirement to boil the solution when we were at about 1.0mL within the equivalence point. This was aimed at expelling carbon dioxide. However, because my lab partner and I did not do this part, the change in Ph which was expected to increase steadily was not the case. The pH was still low due to presence of dissolved CO_2 which lowers pH of solutions. A graph of Ph against concentration of HCL denoted that as concentration of HCL increases, the pH decreased. This is because of increase concentration of hydronium ions with results from complete dissociation of HCL. They lower the PH. The reading of second equivalence volume was almost equal to twice the reading of first equivalence volume. These readings were obtained from the plots of first and second derivative plots respectively. Citation 1. Lanigan, Katherine, Exp6 handout, CHM3880 University of Detroit Mercy Fall 2012 2. Lanigan, Katherine, Exp5 handout, CHM3880 University of Detroit Mercy Fall 2012