Alan Yu

Section 01

TA: Supriya

Complexometric Titration

	Abstract containing best values of Mg^{2+}, Ca^{2+} and total hardness	Max	Pts
	Introduction, etc.		
	All chemical equations and color of appropriate species. $MgY^{2-} + Ca^{2+} \rightarrow$ (from 1.00:1.00 M EDTA, Mg^{2+} addition Titration of Ca^{2+} with EDTA Mg^{2+} reacting to form species with red color Formation of blue species at end point Identification of the two colored species		
	Calculation to determine the concentration of standardized EDTA		
	Relative standard deviation %		
	The reason two different indicators are used		
	Accuracy of Mg^{2+} concentration		
	Accuracy of Ca^{2+} concentration		
	Total hardness calculation and value		
	Compare calculated values to literature values. Cite source.		
	Answers to questions. Presentation, etc.		

Abstract:

The calculated values for Ca^{2+} was .00868M average, 8.68mM, and .348ppt. For Magnesium it was .04708M, 47.08mM, and 1.144ppt. For the standardization for EDTA, the average was .01052M.

Introduction:

This experiment used the formation of complex species. The formation of a complex species was used to determine the concentration of Ca^{2+}, Mg^{2+} and the total hardness of the seawater samples. Since seawater is abundant, the hardness of the water also determines how usable the seawater is for better purification purposes. If the liquid is "harder", there are more procedures that are needed to be done to purify the specific sample.

Experimental Methods:

Through conducting the experiment, a new form of titration is introduced. This type of titration is through the use of a complex ion to form a complex species. To begin, a standardization for the EDTA solution prepared must be tested. This was done through a titration with 4g of EDTA and .4g of $CaCO_3$. After creating the solution of EDTA, a 1L bottle was used to store the EDTA titrating solution. Titration was done to the prepared $CaCO_3$ solution to get a standardization of the EDTA titrating solution created. After collecting this data, part two of the lab was to determine the hardness of the solution using the standardized EDTA solution through titration. Part three was using the same titrating solution to find the concentration of Ca^{2+} with the help of hydroxynapthol blue instead of relying on EBT alone.

Results and Discussion:

Chemical Equations:

1. $MgY^{2-} + Ca^{2+} \rightarrow$ (from 1:1 M EDTA, Mg^{2+} addition)
    a. $MgY^{2-} + Ca^{2+} \rightarrow Mg^{2+} + CaY^{2-}$
2. Titration of Ca^{2+} with EDTA
    a. $Ca^{2+} + Y^{4-} \rightarrow CaY^{2-}$
3. Mg^{2+} reacting to form species with red color
    a. $HY^{3-} + Mg^{2+} \rightarrow MgY^{2-} + H^+$
        i. Creates a red species in the solution
4. Formation of blue species at end point
    a. $HY^{3-} + MgIn^- \rightarrow MgY^{2-} + HIn^{2-}$
        i. From a reddish color to a violet/blueish color
5. Identification of the two colored species
    a. MgY^{2-} and CaY^{2-}

Table I: Raw Collected Data

EDTA Mass	3.9900g
CaCO3 Mass	.4002g
Trial 1:	

Start: 0mL	End: 30.0mL
Trial 2:	
Start: 0mL	End: 41.30mL
Trial 3:	
Start: 1.4mL	End: 48.2mL
Hardness:	
Trial 1:	
Start: 0mL	End: 26.60mL
Trial 2:	
Start: 0mL	End: 26.40mL
Part 3: Ca2+ Concentration	
Trial 1:	
Start: 0mL	End: 8.1mL
Trial 2:	
Start: 8.1mL	End: 16.5mL

This table includes the raw data collected to produce the calculated results from parts one to three of the lab.

Part 1: Standardization of EDTA titration solution

3.990g EDTA x 1 mol EDTA / 372.25g EDTA x 1/1L = .01072M EDTA

.4002g $CaCO_3$ x 1mol $CaCO_3$ / 100.0869g x 1mol Ca^{2+} / 1 mol $CaCO_3$ = .003999mol Ca^{2+} / .25L = .015996M Ca^{2+}

Trial 1:

25mL x .015996M = 30.0mL x M2 = .01333M EDTA

Trial 2:

25mL x .015996M = 41.30mL x M2 = .00968M EDTA

Trial 3:

25mL x .015996M = 46.80mL x M2 = .00854M EDTA

Average EDTA Molarity: (.01333M + .00968M + .00854M) / 3 = .01052M EDTA

Part 2: Total Hardness of Mg^{2+} and Ca^{2+}

Trial 1:

.005L x M1 = .01052M x .0266L = .05597M

Trial 2:

.005L x M1 = .01052M x .0264L = .05555M

Average Hardness: (.05555M + .05597M) / 2 = .05576M x 1000mM / 1 mM = 55.76mM

Part 3: Ca2+ Contents

Trial 1:

.01L x M1 = .01052M x .0081L = .00852M Ca2+

Trial 2:

.01L x M1 = .01052M x .0084L = .00884M Ca2+

Average Ca2+ Content: (.00884M + .00852M) / 2 = .00868M Ca2+

.00868M Ca2+ x 1000 = 8.68mM Ca2+

.00868M Ca2+ x 40.078g/mol Ca2+ = .348ppt

Magnesium Calculations:

.05576M - .00868M Ca2+ = .04708M Mg2+

.04708M Mg2+ x 1000 = 47.08mM Mg2+

.04708M Mg2+ x 24.305g/mol Mg2+ = 1.144 ppt

Table II: Calculated Values

Part 1	
Concentration of prepared Ca2+	.015996M Ca2+
Trial 1 EDTA:	.01333M EDTA
Trial 2 EDTA:	.00968M EDTA
Trial 3 EDTA:	.00854M EDTA
Average EDTA Molarity:	.01052M EDTA
Part 2	
Trial 1 Hardness:	.05597M
Trial 2 Hardness:	.05555M
Average Hardness:	.05576M
Average Hardness in mM:	55.76mM
Part 3	
Trial 1 Ca2+ Content:	.00852M Ca2+
Trial 2 Ca2+ Content:	.00884M Ca2+
Average Ca2+ Content:	.00868M Ca2+
Ca2+ Content in mM:	8.68mM Ca2+
Ca2+ Content in ppt:	.348ppt
Magnesium	
Mg2+ Content:	.04708M Mg2+
Mg2+ Content in mM:	47.08mM Mg2+
Mg2+ Content in ppt:	1.144 ppt

This table includes all the calculated values from collected values during the experiment.

Table III:

Comparisons with LEO-15			
Species	**Experimental Value**	**LEO-15**	**% Error**
Calcium	.348 ppt	.400 ppt	13%
Magnesium	1.144 ppt	1.272 ppt	10.06%

This table includes the comparisons on experimental values and LEO-15 values for Calcium and Magnesium as well as percent error.

Table IV:

Standard Deviation % for EDTA	23.79%

This table includes the standard deviation percent for the standardization of EDTA over three trials.

Percent Error Calculations:

Calcium: (.4 - .348) / .4 x 100 = 13%

Magnesium: (1.272 – 1.144) / 1.272 x 100 = 10.06%

Lab Questions:

1. Why is it important to buffer the solution?
    a. When the solution has buffer added to it, the EBT indicator could act properly under the correct pH conditions and to keep the solution with stable conditions.
2. What is the purpose of this last addition? You will notice that the molar ratio of this solution is given to three significant figures. What error would be introduced if the ratio were slightly less than 1.00 to 1.00? Slightly greater?
    a. When the indicator is added, some of the Ca^{2+} will bind the the indicator which creates a really unstable species. The addition of magnesium introduces a better formation with the indicator which allows more Ca^{2+} to be accounted for during the experiment. It will mess with the stoichiometry of the experiment.
3. What is the chemical reaction that describes the re-dissolution of $Ca(OH)_2$?
    a. $Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$
4. An explanation of why two different indicators are needed in this laboratory?
    a. The EBT is used for the pH range being between 6.3 to 11.5 when the solution gets added with the buffer of pH of 10. The other indicator, hydroxynapthol blue, has a pH range between 12 and 13 which also turns reddish pink with the presence of calcium ions and deep blue with excess calcium ions.