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Analytical Chemistry

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Alkalinity of Seawater

Abstract:

Introduction:

Experimental Methods:

Inclusion of Raw Data:

Table I: Raw Collected Data

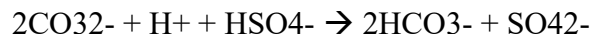
Results and Discussions:

Net Ionic Equations:

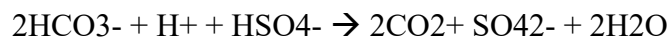
Na₂CO₃ dissolving in the acid:



1st End Point:



2nd End Point:



Part I: Indicator Titration:

Table II: Part I Calculated Results

Calculations:

Mass of Na₂CO₃ = 105.9998g/mol

Molarity of Sulfuric Acid solution:

$$\text{Trial 1: } .0204\text{g} / 105.9998\text{g/mol} \times 1 / 23.90\text{mL} \times 1000\text{mL} / 1\text{L} = .00805\text{M}$$

$$\text{Trial 2: } .0207\text{g} / 105.9998\text{g/mol} \times 1 / 23.40\text{mL} \times 1000\text{mL} / 1\text{L} = .00835\text{M}$$

$$\text{Average: } (.00835\text{M} + .00805\text{M}) / 2 = .0082\text{M}$$

Indicator Titrations:

Concentration of CO₃²⁻ in Seawater based on Indicator:

Both trials is 0 considering the color of the sample did not change when the phenolphthalein was added.

Concentration of HCO₃⁻ in Seawater based on Indicator:

Trial 1:

$$\frac{14.50\text{mL H}_2\text{SO}_4 \times 1\text{L} / 1000\text{mL} \times .0082\text{M} \times 2\text{mol CO}_3^{2-} / 1\text{mol H}_2\text{SO}_4 \times 1 / .1\text{L seawater}}{= .002378\text{M CO}_3^{2-}}$$

Trial 2:

$$\frac{14.10\text{mL H}_2\text{SO}_4 \times 1\text{L} / 1000\text{mL} \times .0082\text{M} \times 2\text{mol CO}_3^{2-} / 1\text{mol H}_2\text{SO}_4 \times 1 / .1\text{L seawater}}{= .0023124\text{M CO}_3^{2-}}$$

Average Concentration: .002345M

Alkalinity based on Indicator Titration:

$$[\text{Alk}] = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}]$$

$$[\text{Alk}] = .002345\text{M} + 2(0\text{M}) = .002345\text{M}$$

Part I Discussions:

Part II: pH Meter Titrations:

Table III: Part II Calculated Results

pH Titrations:

pK₁ and K₁:

Na₂CO₃:

$$\text{pK}_1: 5.2 / = 2.6\text{mL, pH at } 2.6\text{mL is } \sim 9.49$$

$$\text{K}_1: 10^{-9.49} = 3.24 \times 10^{-10}$$

Trial 1:

$$\text{pK}_1 = 2.4 / 2 = 1.2\text{ mL, pH at } 1.2\text{mL is } 7.91$$

$$\text{K}_1 = 10^{-7.91} = 1.23 \times 10^{-8}$$

Trial 2:

$$\text{pK}_1 = .9 / 2 = .45\text{mL, pH at } .4\text{mL is } 7.81$$

$$\text{K}_1 = 10^{-7.81} = 1.55 \times 10^{-8}$$

$$\text{Average } pK_1 = (7.91 + 7.81) / 2 = 7.86$$

$$\text{Average } K_1 = (1.23 \times 10^{-8} + 1.55 \times 10^{-8}) / 2 = 1.39 \times 10^{-8}$$

pK₂ and K₂:

Na₂CO₃:

$$pK_2: (2.4 + 28.8) / 2 = 15.6 \text{ mL, pH at 15.6 mL} = \sim 6.86$$

$$K_2: 10^{-6.86} = 1.38 \times 10^{-7}$$

Trial 1:

$$pK_2 = (2.4 + 7) / 2 = 4.7 \text{ mL, pH at 4.7 mL is } 6.25$$

$$K_2 = 10^{-6.25} = 5.62 \times 10^{-7}$$

Trial 2:

$$pK_2 = (.9 + 6.9) / 2 = 3.9 \text{ mL, pH at 3.9 mL is } 6.13$$

$$K_2 = 10^{-6.13} = 7.41 \times 10^{-7}$$

$$\text{Average } pK_2: (6.25 + 6.13) / 2 = 6.19$$

$$\text{Average } K_2: (5.62 \times 10^{-7} + 7.41 \times 10^{-7}) / 2 = 6.52 \times 10^{-7}$$

Concentration of CO₃²⁻ in Seawater:

Trial 1:

$$.0082 \text{ M} \times 2 \text{ mol CO}_3^{2-} / .05 \text{ L} \times .0023 \text{ L} = .00105 \text{ M}$$

Trial 2:

$$.0082 \text{ M} \times 2 \text{ mol CO}_3^{2-} / .05 \text{ L} \times .0009 \text{ L} = 2.952 \times 10^{-4} \text{ M}$$

$$\text{Average Concentration: } (.00105 \text{ M} + 2.952 \times 10^{-4} \text{ M}) / 2 = 6.726 \times 10^{-4} \text{ M}$$

Concentration of HCO₃⁻ in Seawater:

Trial 1:

$$7.7 \text{ mL} - 2.3 \text{ mL} = 5.4 \text{ mL} - 2.3 \text{ mL} = 3.1 \text{ mL for } 2^{\text{nd}} \text{ eqv point.}$$

$$.0082 \text{ M} \times 2 \text{ mol HCO}_3^- / .05 \text{ L} \times .0031 \text{ L} = .00102 \text{ M}$$

Trial 2:

$$7.5 \text{ mL} - .9 \text{ mL} = 6.6 \text{ mL} - .9 \text{ mL} = 5.7 \text{ mL for } 2^{\text{nd}} \text{ eqv point.}$$

$$.0082 \text{ M} \times 2 \text{ mol CO}_3^{2-} / .05 \text{ L} \times .0057 \text{ L} = .00187 \text{ M}$$

$$\text{Average Concentration: } (.00102 \text{ M} + .00187) / 2 = .00145 \text{ M}$$

Alkalinity Calculation:

$$[\text{Alk}] = [\text{HCO}_3^-] + 2[\text{CO}_3^{2-}]$$

$$[\text{Alk}] = .00102\text{M} + 2(6.726 \times 10^{-4}\text{M}) = .00237\text{M}$$

Part II Discussions:

Overall Experiment Discussions:

Conclusion: