Experiment 5

QUANTITATIVE BASE DETERMINATION BY HCl TITRATION

INTRODUCTION

This is an acid base titration where the titrant is standard HCl, and your sample is a base containing an unknown amount of Na_2CO_3. By titrating the unknown with a standardized HCl solution and knowing the concentration of the HCl titrant, you can determine the total base content in the unknown sample. It is assumed that all of the base present in the sample exists in the form of Na_2CO_3.

PROCEDURE[(a)]

Prepare ~1-L of ~0.1 M HCl solution using the 6 M stock HCl solution. (You'll need to calculate the volume of 6 M HCl that you'll need to use and dilute to ~1 L with deionized water.) Use the 1-L glass bottle for storing your HCl solution.

To standardize the HCl, it is possible to use weighed samples of primary standard sodium carbonate to titrate with the ~0.1 M HCl that you've just prepared. The following text describes the procedure for standardizing an HCl titrant. Once the HCl is standardized, weighed samples of the unknown are then titrated with the standardized HCl. The Na_2CO_3 content of the samples can then be calculated.

HCl Standardization

Accurately weigh three samples (about 0.1. to 0.12 grams each) of pure and dried Na_2CO_3 into three 250-mL Erlenmeyer flasks. Dissolve each sample in about 50 mL of deionized water and add 2 or 3 drops of Methyl purple. Titrate each sample with ~0.1 M HCl. Methyl purple is green in basic and purple in acidic solution. The solution of Na_2CO_3 is basic. As soon as the solution has turned purple remove the CO_2 by boiling the solution gently for about 5 minutes. Cool the solution to room temperature and complete the titration (use of an ice bath may expedite the cooling process).

Note: During boiling the indicator will turn green again as the CO_2 is expelled. If the solution does not return to a green color, you have over titrated. When completing the titration there should be a sharp color change to purple signaling the endpoint. If the endpoint is not sharp the second time, repeat the boiling and then finish the titration as before.

Now analyze your unknown carbonate. Accurately weigh out three samples of 0.25-0.34 grams each into 250-mL Erlenmeyer flasks, dissolve each in ~ 50 mL of deionized water and titrate as described in the previous paragraph.

Save any leftover HCl; you will need it in future labs.

(a) NOTES

(1) Use only boiled deionized water for all solutions except for preparation of the 0.1 M HCl solution. Boil about 500 mL of deionized water about 5 minutes, cool, and then store in glass bottles (careful, don't pour boiling water into a bottle which is not pyrex).

(2) Do not dissolve the primary standard Na_2CO_3 or unknown samples until you are ready to titrate a specific sample. They may gain CO_2 from the atmosphere.

(3) Do your titrations as rapidly as possible without sacrificing accuracy. The solutions will slowly pick up CO_2 from the atmosphere.

(4) Save your left-over HCl solution.

(5) The calculations for this laboratory are very similar to the ones used in the previous lab. The only difference is that you need to take into account reaction stoichiometry because it takes 2 moles of acid to react 1 mole of CO_3^{2-}.

Fill out and hand in the results sheet.

Carbonate Acid-Base Titration Results Sheet

Name: _____

Unknown Number: _____ % Na_2CO_3: _____ (Filled in by grader)

Standardization Titrations

Na_2CO_3 Mass (mg)	HCl Volume (mL)	HCl Molarity (mmol/mL)

Average HCl Molarity ± standard deviation: _____

Relative uncertainty in HCl Molarity: _____

Unknown Titrations

Unknown Mass (mg)	HCl Volume (mL)	Mass % Na_2CO_3

Relative uncertainty in unknown titrations: _____

Propagated relative uncertainty associated with overall analysis: _____

Average % Na_2CO_3 in unknown (reported result): _____

Absolute standard deviation of % Na_2CO_3 in unknown: _____

95% Confidence Interval of % Na_2CO_3 in unknown: _____

Grade _____