CHEM 231

Experiment 6

Determination of the Atomic Mass of Calcium by Titration

Calcium is a very active metal which can be oxidized by water. When the metal is oxidized, water molecules make hydrogen gas and hydroxide ion. The amount of hydroxide produced can be determined by the common technique of acid/base titration.

The purpose of this experiment is to investigate the oxidation of calcium by water and similar reactions, to learn about the technique of analysis by titration, and to use the results this analysis to find the atomic mass of this metal.

Preliminaries

Watch the video (link on content page) for general instructions on doing titrations.

In advance of lab, write an introduction to the experiment and answer the questions below.

The reaction used to standardize the hydrochloric acid solution is the reaction between sodium carbonate and hydrochloric acid producing carbon dioxide and water. What is the balanced equation for this process?

What is the balanced equation for the reaction of calcium metal with water? (Calcium hydroxide and hydrogen gas are produced.)

What is the balanced equation for the titration of calcium hydroxide with hydrochloric acid?

What is the formula weight of sodium carbonate?

What is the atomic weight of calcium?

Procedure

Step 1: Preparation of HCl solution

Prepare 1 L of a 0.3 M solution of HCl. This may be done by measuring 25 mL of concentrated HCl into 1 L reagent bottle and filling with distilled water. You may prepare one bottle per lab table. The concentration of this solution is known only approximately. It must be standardized before it can be used in a titration.

Step 2: Standardization of HCl

To standardize the HCl, we will titrate a precisely weighed amount of solid sodium carbonate, the primary standard.

Obtain a sample of sodium carbonate from the oven (approx. 2 g) in a weighing bottle and allow to cool in a dessicator. Precisely weigh by difference 2-4 samples from the weighing bottle into 250 mL Erlenmeyer flasks. Add 50-100 mL of distilled water to each flask and swirl gently to dissolve.

Add drops of bromocresol green indicator to one of the flasks until it is deep blue. Titrate with the HCl solution to a green color. At this point stop the titration and boil the solution for 2 to 3 minutes. The purpose of the boiling is to remove dissolved carbon dioxide from the solution. Allow to cool and wash the inside walls of the flask with distilled water. After allowing the flask to cool, titrate to a yellow endpoint.

Repeat this procedure with the other samples.

For each sample calculate the following:

Moles sodium carbonate from its mass and its molecular weight: _____

From balanced chemical reaction, there are 2 moles HCl for each mole of sodium carbonate. Calculate moles HCl:_____

Divide moles HCl by Liters HCl from titration to get molarity HCl _____.

If the calculated molarities are not consistent, continue repeating titrations until they are. Average at least 3 good results to find the best value for the molarity of the HCl solution. This value will be used in the second part of the experiment.

Step 3: Reaction of calcium and titration of the products

In this part of the experiment, we react calcium metal with water. The resulting hydroxide ion is titrated with our standardized HCl solution. The moles of HCl used allows us to determine moles of hydroxide which, in turn, allows us to calculate moles of calcium.

Cut 1-2 samples of calcium metal of about 0.2 g each from the calcium turnings provided. Weigh each precisely and record in your notebook.

Add each calcium metal sample to a 250-mL Erlenmeyer flask. Add about 100 mL of distilled water to the flask. Swirling the flask may speed the reaction. If the calcium turnings are fresh, the calcium should react vigorously and completely. If they are not fresh, it may be necessary to heat the flask until the calcium has completely reacted.

For each sample, add bromocresol green and titrate to a yellow endpoint. Use the tirated volumes to calculate the following for each sample:

Moles of HCl added (from buret volume and standardized molarity of HCl):_____

This is equal to moles of hydroxide in the sample.

Moles of Ca (from moles OH^- and balanced reaction): _____

Atomic mass of Ca (from mass used and moles as calculated in last step):_____

Analysis and summary

Clearly summarize all calculations as outlined above. The final result is a determination of the atomic mass of calcium. Comment on how the results compare with the known value and the reasons for any discrepancy.