Gravimetric Analysis of an Ionic Compound

Purpose:

The purpose of this lab was to determine the identity of the metal in an unknown metal carbonate.

Pre-Lab:

1. $1.838\text{ g } CaCO_3 \times \frac{1\ mol\ CaCO3}{100.09\ g\ CaCO3}$
2. $0.01836\text{ mol } CaCO_3 \times \frac{1\ mol\ M2CO3}{1\ mol\ CaCO3} = 0.01836\text{ mol } M_2CO_3$

   $1.972\ g - 1.1016\ g = 0.8704\ g \div 2 = 0.4352\ g \div 0.01836\ mol = 23.7\ \text{ mol}$
3. Lorem Ipsum Dolor
   a. $73.88\ \frac{g}{mol}$
   b. $106\ \frac{g}{mol}$
   c. $138.2\ \frac{g}{mol}$
4. Na_2CO_3
5. $\frac{|107.4-106|}{106} \times 100 = 1.32\%$

Materials:

- 125 mL $CaCl_2$, 0.2 M
- M_2CO_3, 2 g
- 200 mL distilled water
- 0.001-g analytical balance
- 2 400 mL beakers
- Bunsen burner
- Crucible and lid
- 250-mL graduated cylinder
- Watch glass
- Filter paper
- Filter funnel

Procedure:

1. Set up a crucible with a bunsen burner beneath it and brush the bottom of the crucible with the flame for roughly one minute, then allow it to cool. Record its mass.
2. While the crucible is still on the balance, add 2 g of M_2CO_3 to the crucible and record the combined mass of the compound and crucible.
3. Return the crucible to the bunsen burner and continue brushing it with the flame for 2 to 3 minutes. Allow the crucible to cool. Record the combined mass of the crucible and M_2CO_3. Repeat dehydration until the mass no longer changes.
4. Add the anhydrous metal carbonate to a 400-mL beaker along with 200 mL of distilled water and stir until it's totally dissolved.
5. Add 125 mL 0.2 M $CaCl_2$ solution to the beaker and stir, then allow the precipitate to settle for 5 minutes.
6. Record the mass of a piece of filter paper and then fold the paper into a cone (fold in half and crease, then fold in half again. Tear off one corner from the top edge and place the torn corner in the bottom of the filter paper cone.
7. Place the filter paper into a funnel and then wet the walls of the paper with distilled water, then push the filter paper tightly against the walls of the funnel. Set up the funnel in a ring stand over a separate 400-mL beaker.
8. Decant the liquid into the funnel until all but roughly 10 mL of the mixture has drained off, then swirl the precipitate along with a small amount of extra deionized water. Continue decanting until no precipitate is left in the beaker.
9. Transfer the filter paper to a watch glass and then put it in a drying oven set at 120 ºC, allowing it to dry overnight.
10. Remove the filter paper from the oven and allow the watch glass to cool. Record the mass of the filter paper and $CaCO_3$.
11. Return to the drying oven for another 10 minutes. Record the mass of the filter paper and $CaCO_3$. Repeat until the mass no longer changes.

Measurements:

- Mass of an object/compound
- Volume of a liquid

Data/Observations:

Mass of crucible	34.620 g
Mass of crucible and M_2CO_3	36.672 g
Mass of crucible and M_2CO_3, dried once	36.650 g
Mass of crucible and M_2CO_3, dried twice	36.627 g
Mass of M_2CO_3	2.007 g
Mass of filter paper	2.252 g
Mass of filter paper and $CaCO_3$	3.755 g
Mass of filter paper and $CaCO_3$, dried once	3.620 g
Mass of $CaCO_3$	1.368 g
Moles of $CaCO_3$	0.01367 mol
Molar mass of M_2CO_3	146.6 $\frac{g}{mol}$
Identity of M_2CO_3	K_2CO_3
Percent error	6.22%

Calculations:

Calculation of number of moles: $1.368g\ CaCO3 \times \frac{1\ mol\ CaCO3}{100.1g\ CaCO3} = 0.01367$ mol $CaCO_3$

Calculation of molar mass: $\frac{2.007\ g\ M2CO3}{0.01367\ mol\ M2CO3} = 146.8 \frac{g}{mol}$ M_2CO_3

Calculation of % Error: $\frac{|146.8\ g - 138.2\ g|}{138.2\ g} = 6.22\%$ error

Results:

We determined the identity of the unknown metal to be K, potassium.

Analysis:

This experiment was intended to determine the metal within an unknown metal carbonate through gravimetric analysis. From this lab, I learned how to use gravimetric analysis to identify an unknown element in a compound. This is useful because it gives us a method of identifying an unknown compound using known solubility rules and atomic masses.

This experiment is an effective method of identifying a metal in an ionic compound because it utilizes precipitation, stoichiometric mole ratios, and previously known compounds to identify a molar mass which can then be used to identify the metal.

The percent error that was calculated based on our data was 6.22%. One source of error could have resulted from the initial drying of M_2CO_3. During this process, small amounts of metal carbonate flew out of the crucible due to rapid expansion of water, resulting in a slightly lower recorded mass of anhydrous M_2CO_3 and therefore a lower calculated molar mass. Another source of error was after the first drying of the filter paper. When the $CaCO_3$ was being crushed up on the paper, the stiffness of the paper caused it to pop, sending small amounts of $CaCO_3$ flying off the paper. This would result in a higher calculated molar mass.

This lab is worth repeating. Repetition of the lab would result in correction of previous errors and therefore would turn out with more accurate results. Also, repetition would allow one to develop their ability to properly work with bunsen burners and the proper handling of dangerously hot objects such as a crucible.