Identification of a Metal Carbonate

Experiment 3: A study in stoichiometry

Metal carbonates react with hydrochloric acid to produce water and carbon dioxide gas. This is the "acid test" used by geologists to identify carbonate containing rocks and minerals. The equation for this reaction, as it pertains to this experiment, is:

$$M_2CO_{3\,(s)} + 2\ HCl_{\,(aq)} \rightarrow 2\ MCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

or for a bicarbonate (hydrogen carbonate):

$$MHCO_{3(s)} + HCl_{(aq)} \rightarrow MCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Carbon dioxide is fairly soluble in water under high pressure conditions, as evidenced in carbonated soft drinks, however at normal atmospheric pressure the carbon dioxide escapes and the carbonated beverage goes flat if left without being tightly capped.

In this experiment, a weighted sample of unknown metal carbonate will chemically react and the mass of carbon dioxide escaping will be determined. This will provide the data needed to calculate the molar mass of the unknown and determine which of the substances listed in Table 1 can be identified as the unknown metal carbonate. WARNING! Some of the unknowns as well as the hydrochloric acid used in this experiment are very corrosive substances. Wear Eye Protection and avoid skin contact. Wash with running water if exposed.

PRE-LAB ASSIGNMENT: In the space provided in Table 1, write the chemical name and molar mass for each of the following carbonates.

Table 1: Metal Carbonate Unknowns

CHEMICAL NAME	CHEMICAL FORMULA	MOLAR MASS
	Na_2CO_3	
	Na_2CO_3 . ½ H2O	
	$NaHCO_3$	
	K_2CO_3	
	$KHCO_3$	
	K_2CO_3 . ½ H_2O	

PROCEDURE

Measure 10.0 mL of 4.0 M HCl into a 50 or 100 mL graduated cylinder. Pour the acid into a pre-weighed small Styrofoam cup. Take care not to get any acid on the outside of the cup. Wipe off any spills with a paper towel. Take the cup, sample, 125 mL Erlenmeyer flask, and lab notebook to the balance room. It is important not to use too large a flask since a larger flask may exceed the capacity of the balance. Carefully weigh the Erlenmeyer flask on the analytical balance, recording all significant figures for the measurement in your lab notebook. Remove the flask from the balance then add approximately 2 g* of the unknown sample from the vial. It is good practice to use the same balance for every relative weighing throughout an experiment to minimize balance errors. Weigh the flask containing the sample to the nearest 0.0001 gram. *(The approximately weighed sample can be measured using the centigram balance and weighing boat.)

Next place the Styrofoam cup containing HCl carefully on top of the flask in the balance. You may need to open the top of the balance. Record the total mass of flask, sample, cup, and HCl in your lab notebook. Tare the balance then re-measure the weight of the cup and HCl only, record that data as a backup measurement.

Return to your workbench to complete the rest of the experiment. This will protect the balances from any corrosive mist that may be produced in the reaction as well as from any potential accidental spills. Slowly pour all of the acid from the cup into the flask. If you pour too quickly, the reaction might foam over the top of the flask. Touch the hanging drop of acid on the lip of the cup to the inside of the lip of the Erlenmeyer flask to avoid spillage. After the effervescence subsides, gently swirl the flask's contents and blow your breath softly into the flask for about a minute to disperse the heavy carbon dioxide gas being produced. Do not inhale the corrosive mist and wear safety glasses.

Return to the balance room and weigh the flask and contents and the empty cup together on the same balance used previously. Record the combined mass, with correct significant figures, in your lab notebook. The flask contents may be disposed in the laboratory sink and washed away with running tap water. Repeat the entire experiment with the same unknown for two more trials. Wash all of the equipment with DI (deionized) water when the experiment is completed and return everything to the appropriate storage place.

CALCULATIONS

Calculate the mass of the sample from the measured mass of the empty flask compared to the measured mass of the flask containing the sample. Calculate the mass of carbon dioxide produced. Hint: consider the mass of the flask containing the sample and the cup containing acid to the mass collected for the flask containing residual contents and empty cup. Next determine the moles of carbon dioxide produced (Hint: molar mass of carbon dioxide), the moles of unknown sample (Hint: balanced equation), and then the molar mass of the unknown sample in grams/mole. Use Table 1 to identify the unknown sample.

Name: ______________________________

Report Sheet for Experiment 3:
Identification of a Metal Carbonate
Unknown Number: _____________

Date: ____________
Section: __________

DATA:

MASS	**Trial 1**	**Trial 2**	**Trial 3**
Mass of empty flask			
Mass of empty cup			
Mass of flask+sample			
Mass of cup + acid			
Mass of flask+sample & cup+acid (before reaction)			
Mass of flask+contents & cup (after reaction)			

CALCULATIONS

	Trial 1	Trial 2	Trial 3
Mass of sample			
Mass of carbon dioxide			
Moles of carbon dioxide			
Moles of sample			
Molar Mass of unknown			

Sample Calculation: Trial ____

Report Sheet for Experiment 3:
Identification of a Metal Carbonate

Date: ____________
Section: __________

Post-Questions

1. Which compound from Table 1 is your Unknown? ______________________________

2a. How would the mass after the reaction be changed if a student failed to blow the dense carbon dioxide gas out of the flask before weighing the final mixture?

2b. How would this change the calculated molar mass of the unknown?

3. Calculate the deviation (d, review experiment 2) of your calculated molar mass from the tabular value for your unknown.

4. Calculate the percentage error for your results.

5. Predict and explain what change may occur, if any, as a result of a small chip of glass remaining in the flask throughout the experiment. How would your results change if the small bit of glass was removed midway through the experiment?