Experiment 3: IDENTIFICATION OF A METAL CARBONATE BY REACTION WITH ACID

Metal carbonates and bicarbonates react with hydrochloric acid to produce metal chlorides, water and carbon dioxide gas. This is the "acid test" used by geologists to identify carbonate containing rocks and minerals. An equation for the reaction of a carbonate is:

$$M_2CO_3 + 2\ HCl \rightarrow 2\ MCl + H_2O + CO_2$$

Or for a bicarbonate:

$$MHCO_3 + HCl \rightarrow MCl + H_2O + CO_2$$

where M = Na or K.

Carbon dioxide is fairly soluble in water under high pressure conditions, as evidenced in soft drinks. However, at normal atmospheric pressure, the carbon dioxide escapes and the carbonated beverage goes flat if left opened.

In this experiment you will react a weighed sample of unknown metal carbonate and determine the mass of CO_2 that escapes. This will provide the data needed to calculate the molar mass of the unknown and determine its identity. The unknowns used in this experiment are listed in Table 1. Note that one mole of any of the substances used for your unknown will produce one mole of carbon dioxide.

WARNING!
Some of the unknowns and the hydrochloric acid used in this experiment are very corrosive substances. **Wear eye protection** and avoid skin contact. Wash with running water if exposed.

EXPERIMENTAL PROCEDURE

Measure 15 ml of 6.0 M hydrochloric acid (HCl) into your 50 or 100 ml graduated cylinder. Pour the acid into a foam cup. Take care not to spill any acid on the outside of the cup. Wipe any spills off with a paper towel. Take the cup, your sample, and a clean 125 mL Ehrlenmeyer flask to the balance room.

It is important not to use too large a flask because a larger flask might take up too much space on the balance pan or exceed the capacity of the balance.

Carefully weigh the Ehrlenmeyer flask on the analytical balance. Don't forget to zero the balance before each weighing. Be sure to keep the balance doors closed as much as possible. Record the mass to the nearest .0001 gram on your report sheet.

Remove the flask from the balance and transfer add between **1.0 and 2.0 g** of your sample from the vial.

It is good practice to use the same balance for every weighing throughout an experiment to minimize errors due to the balance. Weigh flask and sample and record the mass on your report sheet to the nearest .0001 gram.

Place the cup containing the HCl on top of the flask in the balance. You may need to open the top door of the balance. If so, close the door as much as possible without touching the cup. Record the total mass on your report sheet.

Table 1: Metal Carbonates Unknown used in this experiment

Chemical Name	Chemical Formula	Molar Mass
Sodium Carbonate	Na_2CO_3	105.988 grams/mole
Sodium Carbonate · 1/2 hydrate	$Na_2CO_3 \cdot 1/2\ H_2O$	114.996 grams/mole
Sodium Bicarbonate	$NaHCO_3$	84.0066 grams/mole
Potassium Carbonate	K_2CO_3	138.206 grams/mole
Potassium Bicarbonate	$KHCO_3$	100.115 grams/mole
Potassium Carbonate · 1-1/2 hydrate	$K_2CO_3 \cdot 1\text{-}1/2\ H_2O$	165.229 grams/mole

Experimental procedure (continued)

Remove your flask and cup from the balance and take them to your lab bench. This is done to protect the balances and instruments in the weighing room from any corrosive mist that may be produced in the next step.

Slowly pour all of the acid from the cup into your flask. If you pour too quickly the reaction mixture 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 Ehrlenmeyer flask so that none is spilled.

After the effervescence subsides, gently swirl the flask and blow your breath softly into the flask for about a minute to disperse the heavy carbon dioxide gas that has been produced. **Do not inhale the corrosive mist. Wear your safety glasses.**

Return to the balance room and weigh the flask and contents and the empty cup together on the same balance you used before. Record the combined mass on your report page.

The flask contents may be dumped into the laboratory sink and washed away with running water. Wash your equipment and put everything away.

CALCULATIONS

Calculate the mass of the sample by subtracting of the empty flask from the mass of sample + flask.

Calculate the mass of carbon dioxide produced by subtracting the mass of the flask and contents + empty cup from the mass of flask and sample + cup and acid.

Find the moles of CO_2 produced by dividing the grams of carbon dioxide by the conversion factor 44.0095 grams/mole of CO_2.

The moles of unknown sample = moles CO_2 because each mole of sample produces one mole of CO_2 as shown in the balanced equation.

The molar mass of the unknown (grams/mole) is found by dividing the mass of the sample by the moles of the sample. Compare the molar mass of your sample to those in Table 1 to identify your sample.

Name_____

Report Sheet – Experiment 3

Unknown Number_____

Data:	Sample #1	Sample #2
Mass of Empty Flask		
Mass of Flask + Sample		
Mass of All before Mixing		
Mass of All after Reaction		

Calculations:	Sample #1	Sample #2
Mass of Sample		
Mass of Carbon Dioxide		
Moles of Carbon Dioxide		
Moles of Sample		
Molar Mass of Sample		

Average Molar Mass of Sample: _____

Postlaboratory Assignment – Experiment 3

1. Which compound in Table 1 do you think your unknown is? _____

2. What is the deviation of your average molar mass from the tabulated value? (Subtract your average molar mass from the molar mass reported in table 1 and write the difference here.) Show your work.

3. Calculate the percentage error in the calculated value. (Divide the deviation by the tabulated value and multiply the quotient by 100%.) Show your work.

4. How would the mass after reaction be changed if a student failed to blow the dense CO_2 gas out of the flask before weighing the final reaction mixture?

5. How would this change the calculated molar mass of the unknown? Explain your answer clearly in terms of the data you recorded and the calculations that you did.

6. What change, if any, would result in the flask contained a small piece of glass that remained in the flask throughout the experiment? Explain.

Name_____

Prelaboratory Assignment – Experiment 3

1. Why do you think that you are instructed to use **1.0 to 2.0 g** of your sample?

2. A student obtained the following data for this experiment:

Data:	Sample #1
Mass of Empty Flask	75.0235 g
Mass of Flask + Sample	76.8912 g
Mass of All before Mixing	101.5894 g
Mass of All after Reaction	101.0942 g

What is the molecular mass of this student's sample? According to Table 1, which carbonate is it? Show all your work.

3. Using the student's unknown, write the balanced chemical equation for the reaction performed in this experiment.