Stoichiometry: Molar Ratios in a Chemical Reaction

Background: Stoichiometry is the branch of chemistry that studies the mass relationships in chemical reactions and elemental composition of compounds. In this lab you will investigate the stoichiometry of the reaction between sodium hydrogen carbonate and hydrochloric acid.

Objective: To measure the molar ratio of a chemical reaction.

Safety: Wear chemical splash goggles. Hydrochloric acid (3 M) is corrosive; use caution: If you spill it on your skin, immediately report it to your teacher. Use caution in heating the evaporating dish.

Disposal: Flush the residue in the evaporating dish down the drain.

Materials

• Bunsen burner	• iron ring
• sodium hydrogen carbonate	• beral pipet
• ring stand	• 150 ml beaker
• centigram or electronic balance	• crucible tongs
• ceramic plate	• watch glass
• 3 M hydrochloric acid	• ceramic-centered wire gauze
• evaporating dish	• graduated cylinder

Procedure

1. Place a watch glass over an evaporating dish and determine the mass of the assembly. Record the mass in the Data Table.
2. Remove the watch glass with crucible tongs and place it on a clean ceramic plate.
3. Add approximately 3 g of sodium hydrogen carbonate to the evaporating dish. Replace the watch glass. Determine the mass of the assembly plus contents and record it in the Data Table.
4. Using a graduated cylinder, transfer 10 ml of 3 M hydrochloric acid to a 150 ml beaker. Slowly add the acid to the evaporating dish. Do not allow the reaction to proceed rapidly. Control the rate by adding the acid slowly.
5. After the 10 ml of acid is added, obtain another 10 ml of 3 M hydrochloric acid.
6. Using a beral pipet, add acid drop by drop to the evaporating dish until the bubbling stops. Return the unused acid to the supply table.
7. Set up a heating assembly with a wire gauze supported by an iron ring on a ring stand.
8. Using crucible tongs, transfer the evaporating dish assembly (dish + watch glass) to the ring stand.
9. Light the burner and adjust the flame to maintain a steady boil. As the water evaporates, reduce the flame to prevent splattering.
10. When only a dry white residue remains in the evaporating dish and on the watch glass, transfer the evaporating dish assembly to a ceramic tile to cool.
11. Place the cooled evaporating dish assembly on the balance, determine its mass, and record the

mass in the Data Table.

12. Reheat the evaporating dish assembly for an additional five minutes, cool, and remass. If the difference between the two masses is 0.01 g or less, record the second mass in the Data Table. If the mass difference is greater than 0.01 g, repeat the heating. Cool the assembly and re-mass. Record this mass as the constant mass.
13. Flush the residue in the evaporating dish down the drain.
14. Wash your glassware and return it to the lab locker.

Calculations (Be sure to retain your significant figures)

1. Use the recorded masses to calculate the mass of $NaHCO_3$.
2. Using the calculated mass of $NaHCO_3$ calculate the moles of $NaHCO_3$.
   1 mol $NaHCO_3$ = 84.006 g $NaHCO_3$.
3. Use the recorded masses to calculate the mass of NaCl
4. Using the calculated mass of NaCl calculate the moles of NaCl. I mol NaCl = 58.443 g NaCl.
5. Calculate the observed molar ratio of $NaHCO_3$ to NaCl.
6. Determine the accepted molar ratio by balancing the equation (hint: Think acid base neutralization. Since the base is a carbonate, you will also get carbon dioxide).
7. Calculate your absolute error and percent relative error. Show your work right on the sheet.

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Data Table

mass of evaporating dish and watch glass	
mass of evaporating dish, watch glass, and contents	
mass after first heating	
mass after second heating	
constant mass	

Calculations Table

mass of $NaHCO_3$	
moles of $NaHCO_3$	
mass of NaCl	
moles of NaCl	
molar ratio (observed)	
molar ratio (accepted)	
absolute error	
percent relative error	