The Mass of a Reaction Product: Prediction Using Stoichiometry vs. Experimental Determination

EXPERIMENT 6C

In many industrial processes one of the reactants is used in excess to make sure that the other reactant is completely consumed. The reactant in excess is the least expensive reactant or the one that is easiest to isolate and reclaim.

In this experiment, you will calculate the number of milliliters of 1.00*M* HCl required to react with the amount of sodium carbonate in your beaker. You will then add that amount plus an excess of ten percent to make sure all of the sodium carbonate reacts.

The mass of the product can be calculated using the principles of stoichiometry and the knowledge of which reactant is in excess. The product will then be isolated and the mass measured to determine whether it agrees with the predicted mass, within experimental uncertainty.

OBJECTIVES

1. to review types of reactions
2. to review writing and balancing an equation
3. to use the principles of stoichiometry to calculate the amount of one reactant that will completely react with another reactant
4. to review the use of percent, in order to calculate the amount to add to have a ten percent excess
5. to use the principles of stoichiometry and limiting reactants to predict the amount of a product
6. to review the use of significant digits in calculations

MATERIALS

Apparatus

centigram balance
1 beaker (150- or 250-mL)
graduated cylinder (25- or 50-mL)
hot plate (for class use)
safety goggles
lab apron
fume hood

Reagents

sodium carbonate
1*M* HCl

PRELAB

Answer questions 1-6 on the Report Sheet.

PROCEDURE

Part I

CAUTION: Hydrochloric acid is corrosive to skin, eyes, and clothing. When handling 1M hydrochloric acid, wear safety goggles and lab apron. Wash spills and splashes off your skin and clothing immediately using plenty of water. Call your teacher.

1. Put on your laboratory apron and safety goggles.
2. Measure the mass of a clean, dry beaker marked with your name, and record the data on the Report Sheet.
3. Add between 3 and 5 grams of sodium carbonate to the beaker.
4. Measure the combined mass of the beaker and sodium carbonate and record the data on the Report Sheet.
5. Do calculations 1-5 on the Report Sheet.
6. Check your calculations for volume needed of 1*M* HCl with your teacher, and if approved, add that amount of 1*M* HCl to the beaker slowly, using a graduated cylinder.
7. Record your observations on the Report Sheet.
8. Check to make sure your beaker is marked with your name, and place it on the hot plate in the fume hood.
9. Measure the mass of a beaker labeled *Class I* and record the data on the Report Sheet.
10. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.

Part II (the following day)

1. Put on your laboratory apron and safety goggles.
2. Examine the substance in your beaker and record your observations on the Report Sheet.
3. Measure the mass of the beaker and contents, and record the data on the Report Sheet.
4. Measure the mass of the beaker labeled *Class I* and its contents, and record the data on the Report Sheet.
5. Before you leave the laboratory, wash your hands thoroughly with soap and water; use a fingernail brush to clean under your fingernails.

POST LAB DISCUSSION

After all your classmates measured the mass of the beaker labeled *Class I* in Part I of the experiment, 200 mL of 1*M* HCl were added to it. This beaker was then placed on the hot plate in the fume hood. The mass of the beaker was measured in Part II after the 1*M* HCl evaporated. Use the data to answer questions 3 and 4 in the Conclusions.

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Name _____

Class _____ Date _____

EXPERIMENT 6C REPORT SHEET

PRELAB QUESTIONS

1. What is the formula for sodium carbonate? _____
2. What is the formula for hydrochloric acid? _____
3. Write the balanced equation for the reaction of sodium carbonate with hydrochloric acid.

4. Calculate the number of moles in 8.45 g of sodium carbonate. _____

5. Calculate the number of milliliters of 1*M* HCl required for 0.212 mol of HCl. _____

6. When 200 mL of distilled water is evaporated from a beaker, what remains in the beaker? Explain your answer. _____

DATA AND OBSERVATIONS

Part I

1. Mass of clean, dry beaker _____
2. Mass of beaker and sodium carbonate _____
3. Volume of 1*M* HCl to be added, in mL _____
4. Observations during and after adding 1*M* HCl to the beaker containing sodium carbonate

5. Mass of beaker labeled *Class I* _____

Part II

1. Observations of beaker and contents _____

_____

2. Mass of beaker and contents _____

3. Mass of beaker labeled *Class I* _____

CALCULATIONS

Express each answer with the correct number of significant digits. Refer to the balanced equation in Prelab Question 3 as needed.

A. Predicted mass of product

1. Calculate the mass of sodium carbonate in your beaker. _____

2. Calculate the number of moles of sodium carbonate in your beaker. _____

3. Calculate the number of moles of HCl required to just react with the sodium carbonate in your beaker. _____

4. Calculate the volume in mL of 1*M* HCl required to just react with the sodium carbonate in your beaker. _____

5. Calculate the volume in mL of 1*M* HCl required for a ten percent excess. _____

6. Calculate the mass of the product in the beaker using the principles of stoichiometry and limiting reactant. _____

B. Actual mass of product

Calculate the mass of the product in your beaker at the end of the experiment. _____

CONCLUSIONS

1. What is the formula for the product that remains in your beaker? _____
2. Is the predicted mass of the product the same as the measured mass within experimental uncertainty? _____

   _____

   _____
3. Within experimental uncertainty, is the mass of the beaker labeled *Class I* the same before and after 200 mL of 1*M* HCl has been evaporated from it? _____
4. What remains in the beaker labeled *Class I* when 1*M* HCl is evaporated from it? _____

   Explain your answer. _____

   _____

   _____
5. What is the purpose of the beaker labeled *Class I?* _____

   _____

SYNTHESIS

1. If 200 mL of tap water is added to a 250-mL beaker with a known mass, and the water is evaporated, what will remain in the beaker? _____

   _____
2. If the predicted mass of the product in your experiment and the measured mass are not the same within experimental uncertainty, analyze the experiment for causes. _____

   _____

   _____
3. Evaluate the causes to determine which is the most probable one. _____

   _____
4. What is the shape of crystals of the product? _____
5. Have you seen crystals like these before? _____

   If so, where? _____

   _____