Decomposition of Sodium Bicarbonate, NaHCO₃, Stoichiometry Lab

The purpose of this lab is to:

- Perform a decomposition reaction and measure the mass of the product formed
- Use stoichiometry to determine which thermal decomposition reaction occurred during the experiment
- Calculate the percent yield and error for your experiment

BACKGROUND: We use stoichiometry to describe the relationship between the relative quantities of substances taking part in a reaction or forming a compound, and are typically a ratio of whole integers. In this lab, you will use stoichiometry to probe the decomposition of sodium bicarbonate. Sodium bicarbonate may be more familiar to you as baking soda. Baking soda is very commonly listed as an ingredient in recipes for baked goods, pancakes and waffles. As the food item is being cooked or baked, the baking soda undergoes decomposition, releasing gas and causing the food item to “rise” and have a “light” texture.

There are three theoretically possible chemical reactions that could occur during the thermal decomposition of baking soda:

A) sodium bicarbonate (s) → sodium hydroxide (s) + carbon dioxide (g)
B) sodium bicarbonate (s) → sodium oxide (s) + carbon dioxide (g) + water (g)
C) sodium bicarbonate (s)→ sodium carbonate (s) + carbon dioxide (g) + water (g)

By comparing the theoretical yields of the possible solid products with your actual experimental yield of the product, you will try to determine which of the above decomposition reactions occurred.

PRE-LAB QUESTIONS:

1.) Write the balanced chemical equations for these reactions using the correct formulas:

A) sodium bicarbonate (s) → sodium hydroxide (s) + carbon dioxide (g)

B) sodium bicarbonate (s) → sodium oxide (s) + carbon dioxide (g) + water (g)

C) sodium bicarbonate (s)→ sodium carbonate (s) + carbon dioxide (g) + water (g)

2.) Stoichiometry practice. In the following balanced chemical equation, how many grams of CO₂ would be produced when starting with 300g of C₂H₂? (Follow mole map; Show all work.)

\[ 2 \text{C}_2\text{H}_2 + 5 \text{O}_2 (g) \rightarrow 2 \text{H}_2\text{O(g)} + 4 \text{CO}_2 (g) \]
MATERIALS: Scoopula, Bunsen burner, test tube, 400 mL beaker, test tube clamp, NaHCO₃

PROCEDURE:
1) Obtain your materials.
2) Record the mass of the test tube.
3) Put 3 - 4 scoops of sodium bicarbonate into the test tube.
4) Record the mass of the test tube containing the solid NaHCO₃ powder.
5) Using the test tube clamp, heat the test tube over the Bunsen burner for about 5 minutes, then allow to cool for approximately 10 minutes. (Cool the test tube by placing it in the beaker with the test tube clamp still attached.)
6) After allowing the test tube to cool, record the mass of the test tube containing the solid product that remained after the decomposition reaction.
7) Clean up: discard the solid product into the trash container, then clean and scrub the test tube with a test tube brush. Rinse and then place your cleaned test tube into the test tube rack.

DATA:

| A) Mass of empty and clean test tube | _____________g |
| B) Mass of the test tube and sodium bicarbonate | _____________g |
| C) Mass of sodium bicarbonate used in the experiment (B-A) | _____________g |
| D) Moles of sodium bicarbonate used in the experiment | _____________ mol |
| E) Mass of test tube and the decomposition product after heating | _____________g |
| F) Mass of decomposition product (E – A) | _____________g |

DATA ANALYSIS AND POST-LAB QUESTIONS:

1.) Using the moles of sodium bicarbonate actually used in the experiment (data C above), calculate the theoretical yield of products from each of the possible decomposition reaction.

   A) sodium bicarbonate (solid) → sodium hydroxide (solid) + carbon dioxide (gas)

   B) sodium bicarbonate (solid) → sodium oxide (solid) + carbon dioxide (gas) + water (gas)

   C) sodium bicarbonate (solid) → sodium carbonate (solid) + carbon dioxide (gas) + water (gas)

2.) Which theoretical yield agrees with the experimental yield? (A, B, or C?)___

3.) Which balanced chemical reaction actually occurred during this experiment? (A, B, or C?)___

4.) What is the percent yield that you obtained for this reaction? (Round answer to one decimal place.)

Percent yield = __actual yield______ x 100  
Percent yield = _________________ x 100 = theoretical yield