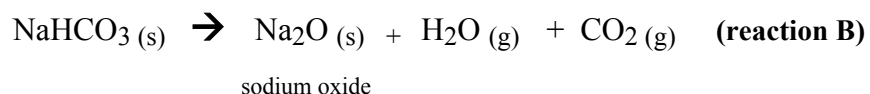
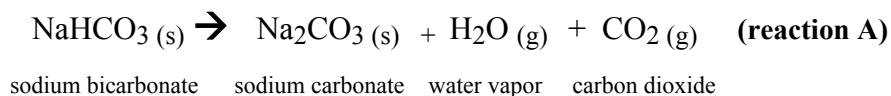


Experiment 13 - Thermal Decomposition of Sodium Bicarbonate

NaHCO_3 (s) is commonly called sodium bicarbonate. When NaHCO_3 is heated above $110\text{ }^\circ\text{C}$ (but not heated to "red heat") it has been observed that both H_2O (g) and CO_2 (g) are evolved by some chemical change, and that after this decomposition is complete, a white solid residue remains. Among possible reactions, the two following unbalanced reactions seem the ones that are most likely to explain these facts:



You are to choose between reactions (A) and (B) on the basis of your laboratory work, which will involve heating a weighed sample of sodium bicarbonate in a crucible and weighing the residue left in your crucible after heating. From the mass of the solid product ("residue"), you should be able to decide if the product of the reaction is Na_2O (s) or Na_2CO_3 (s).

Safety Precautions:

- Wear your safety goggles.
- Use care when handling HCl (aq). If any HCl splashes on your skin or clothes, rinse it off immediately with plenty of water.

Waste Disposal:

- The solid waste may be discarded in one of the regular garbage cans.

Procedure

1. Obtain a clean, dry crucible that has no cracks.

2. Place the crucible in a clay triangle, on a ring attached to a ring stand. Make certain that the crucible hangs securely in the triangle; ask for help if it seems shaky. Put the cover on the crucible.
3. Heat the crucible and cover for 10 minutes with a high flame, until the bottom of the crucible glows red hot. Allow the crucible to cool in the clay triangle. (*This step is to clean out the crucible.*)
4. When they have reached room temperature, weigh the crucible and cover.
5. Add sodium bicarbonate to the crucible until it is 3/4 full. Weigh the crucible, sample, and cover. Obtain the mass of the sample by subtraction.
6. Using a medium-sized flame, heat the sample for 15 minutes. Do NOT heat the sample until it is red hot. Cool it in place as before, and then weigh it. (While you are waiting for the sample to heat and cool, you may start on the calculations.)
7. Heat again, this time for 10 minutes, then cool and weigh as before. If the crucible, cover, and sample weigh the same, then we can be reasonably confident that the sodium bicarbonate has been completely decomposed (i.e. no more H₂O or CO₂ is being produced.)
8. If the crucible plus sample weighs less after this second heating than it did after the first heating, repeat the heating/cooling/weighing sequence as often as is necessary until the mass is constant (usually three times is sufficient).
9. Before you discard your sample, make sure you double-check your results, as described after the Calculations section.

Calculations

1. Balance equations (A) and (B).
2. a) Starting with the mass of sodium bicarbonate that you used, calculate the mass of Na₂CO₃ that should be produced in theory, assuming that reaction A is the one that actually occurs. Show your work.
b) Starting with the mass of sodium bicarbonate that you started with, calculate the mass of Na₂O that should be produced in theory, assuming that reaction B is the one that actually occurs. Show your work.
3. Compare your observed mass of product with those predicted in step 2 of the calculations for Na₂O_(s) and for Na₂CO_{3(s)}. On the basis of these answers, which product was actually formed?
4. Calculate the percent yield of the reaction. Does the result make sense? Explain.

Double-Check Your Results

Carbonate salts such as $\text{Na}_2\text{CO}_3(\text{s})$ react with acids to form CO_2 gas, observed by fizzing. This cannot happen if your product is $\text{Na}_2\text{O}(\text{s})$. After all of your weighing is done, add a few drops of 6 M hydrochloric acid to the solid product in your crucible. Does this test confirm your result from above or not?

Questions

1. If the reaction did not go to completion, would the mass of the residue in the crucible be more or less than it should be? Explain.
2. If you started with 2.486 g of sodium bicarbonate and heated it to constant mass, what would the mass of the residue be after the reaction? Show your work.