**BACKGROUND INFORMATION:**

The law of conservation of mass states that **during any physical or chemical change the total mass of matter will remain the same**. The matter may change in appearance as in a physical change or it may change in a more fundamental way with new molecules present after the change as in a chemical change. In either case, the mass remains constant.

Many household substances should be considered for their chemical properties. Today we will react two household substances, baking soda and vinegar. The chemical name for baking soda is sodium bicarbonate, NaHCO3. Vinegar is composed of 5% acetic acid, HC2H3O2. The sodium bicarbonate is a solid. The acetic acid is in a solution with water as the solvent. The chemical reaction is depicted as:

NaHCO3(*s*) + HC2H3O2(*aq*) 🡪 NaC2H3O2(*aq*) + H2O(*l*) + CO2(*g*)

The most obvious evidence that a chemical reaction has occurred in this reaction is the formation of carbon dioxide, a gas. **We will use this reaction to show the conservation of mass as well as to indicate that gases are matter – that is, that they occupy space and have mass.**

**PROCEDURE:**

1. Measure 25.0 mL of acetic acid (*a*) solution in a 50 mL graduated cylinder. Pour the acid into an empty screw-top bottle. Put the cap on. If the outside of the bottle becomes wet, dry it.
2. Measure and record (*b*) the mass of the *capped* bottle and the acetic acid.
3. Measure and record (*c*) the mass of a small test tube. The test tube must be completely *dry*.
4. Add sodium bicarbonate to the test tube until it is about one-third of the way full.
5. Place the test tube on the electronic balance carefully so that the sodium bicarbonate doesn’t spill. Measure and record (*d*) the mass of the test tube and sodium bicarbonate.
6. Put the test tube into the bottle with the acetic acid solution and tighten the cap.
7. Calculate and record (*e*) the mass of the entire bottle and its contents.
8. While the bottle is sealed, tilt the bottle back and forth gently to allow the reactants to mix. Do not shake the bottle or turn it upside down.
9. Record your qualitative observations. Keep tilting the bottle until the reaction is complete.
10. When the reaction is finished, reweigh the sealed bottle and record (*f*) this mass.
11. Carefully open the bottle to prevent liquid from escaping. Replace the cap.
12. Once the gas has escaped reweigh the entire bottle, capped, with its contents. Record this (*g*).

**MEASUREMENTS: Quantitative Data (7 pts)**

Include all ***units*** and the correct number of decimal places in your measurements.

|  |  |
| --- | --- |
| **Measurement** | **Value** |
| 1. Volume of acetic acid |  |
| 1. Mass of bottle + acetic acid |  |
| 1. Mass of small test tube |  |
| 1. Mass of test tube + sodium bicarbonate |  |
| 1. Total mass BEFORE mixing |  |
| 1. Total mass AFTER mixing *(sealed)* |  |
| 1. Total mass AFTER mixing *(opened)* |  |

**OBSERVATIONS: Qualitative Data (1 pt)**

Use short phrases to describe the reaction as it occurs.

**DATA ANALYSIS: (12 pts)**

1. What evidence indicates that the process is a chemical reaction?

2. How does the data provide evidence for the Law of Conservation of Mass? Cite *specific* data in answering this question.

3. Is there any evidence in the data that shows that carbon dioxide has mass? If so, describe that data.

4. Determine the mass of carbon dioxide gas formed during the reaction. Show and label your numbers, including units.

5. Does the sum of the mass of the test tube + sodium bicarbonate (*d*) and the bottle + acetic acid (*b*) equal the total mass before mixing (*e*)? Why or why not?

6. Which elements are present in the *reactants* of this reaction?

7. Which elements are present in the *products* of this reaction?