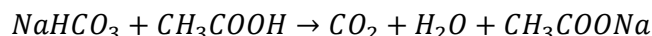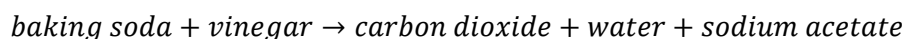Name: _____ Date: _____

Heavy Balloon-Mass Balance Worksheet
Answers

Introduction

For this activity, you will apply the conservation of mass principle to predict how much carbon dioxide is produced for a reaction of 0.1 moles of baking soda and 0.1 moles of vinegar. You will then combine the two chemicals and capture the carbon dioxide in a balloon. Finally, you will weigh the balloon and compare it to the predicted mass.

The first step is to understand the chemical reaction between baking soda and vinegar. The chemical name for baking soda is sodium bicarbonate, and vinegar is a diluted acetic acid. They react to form carbon dioxide, sodium acetate, and water according to the equation below.

$$baking\ soda + vinegar \rightarrow carbon\ dioxide + water + sodium\ acetate$$

$$NaHCO_3 + CH_3COOH \rightarrow CO_2 + H_2O + CH_3COONa$$

This equation gives us the relationship between the moles of products and moles of reactants. Using this information with the known molecular weights, we can calculate how many grams of carbon dioxide will be produced for a given amount of baking soda or vinegar. In other words, by knowing how much mass went into our reaction, we know how much mass should come out.

It is also important to balance the overall mass. Since mass is conserved, the mass of your starting reactants, balloon and bottle should equal the mass of the bottle, its contents, the balloon, and the gas inside the balloon.

Finally, because most stores sell dilute vinegar, you must calculate how many moles of acetic acid are in a given volume of vinegar. Commercial vinegar contains about 5% acid by mass and has a density of approximately one gram per milliliter.

Calculations

Before you start your experiment, calculate the mass of 0.1 moles of baking soda and how many milliliters of vinegar contain 0.1 moles of acetic acid.

Given Data and Physical Constants			
Substance	**Amount (moles)**	**Molecular Weight (g/mol)**	**Density (g/mL)**
baking soda	0.10	84	—
acetic acid	0.10	60	N/A
vinegar	—	—	1.00

(84g/mol BS)(0.1 mol)=8.4 g BS

(60 g/mol AA)(0.1 mol)=6.0 g AA

$$\frac{6.0g\ AA}{0.05\ \frac{g\ AA}{g\ Vin}} = 120\ g\ vinegar$$

(120 g vinegar)(1g/ml)=120 mL vinegar

Note: You could also leave the molecular weight off the table and have students calculate it.

Next, predict how many grams of carbon dioxide the reaction will yield. Carbon dioxide has a molecular weight of 44 grams per mole.

(0.1 mole BS)(1 mol CO_2 / 1 mol BS) = (0.1 mol CO_2) (44 g/mol) = 4.4 grams CO_2

Procedure

One of the most important parts of preparation is simply reading the instructions beforehand. Understand what you will be doing so that you can move quickly and make fewer mistakes. Organization is also very important. Design a table to effectively organize your data.

1. Obtain an empty water bottle, a balloon, and a funnel.

2. Weigh the balloon and the bottle and record their masses in your data table

3. Measure out 0.1 moles (8.4 grams) of baking soda and put it in your water bottle.

4. Pour 0.1 moles (~120 mL vinegar) of acetic acid into a beaker

5. With one person ready to put the balloon on the top of the bottle, use the funnel to pour your vinegar into the bottle. Quickly cover the top with a balloon.

6. Gently swirl the solution to make sure it reacts.

7. When the solution has stopped bubbling and the reaction seems complete, find the mass of the entire apparatus and record it in your data table.

8. Carefully remove the balloon from the bottle, making sure not to let any gas escape from the balloon. Tie it off to be sure none escapes.

9. Weigh the balloon and record your findings.

Data Table

Draw your data table in the space below.