alka seltzer stoichiometry lab answer key

Alka Seltzer Stoichiometry Lab Answer Key

Stoichiometry is a fundamental concept in chemistry that allows scientists to understand and quantify the relationships between reactants and products in chemical reactions. One practical application of stoichiometry can be found in the Alka Seltzer lab experiment, where students can observe the reaction of Alka Seltzer tablets in water. This experiment not only illustrates the principles of chemical reactions but also helps students practice calculations involving molar ratios and the use of balanced chemical equations. In this article, we will explore the stoichiometry of the Alka Seltzer reaction, discuss the lab procedure, and provide a comprehensive answer key for the lab exercise.

Understanding Alka Seltzer and Its Components

Alka Seltzer is an effervescent antacid that contains sodium bicarbonate ($NaHCO_3$), citric acid ($C_6H_8O_7$), and aspirin (acetylsalicylic acid, $C_9H_8O_4$). When the tablet is dropped into water, it undergoes a chemical reaction that produces carbon dioxide gas (CO_2), water (H_2O), and sodium citrate ($C_6H_5Na_3O_7$). The reaction can be summarized by the following balanced chemical equation:

$$
3 \text{NaHCO}_3 (s) + \text{C}_6\text{H}_8\text{O}_7 (aq) \rightarrow \text{C}_6\text{H}_5\text{Na}_3\text{O}_7 (aq) + 3 \text{H}_2\text{O} (l) + 3 \text{CO}_2 (g)
$$

In this equation, three moles of sodium bicarbonate react with one mole of citric acid to produce one mole of sodium citrate, three moles of water, and three moles of carbon dioxide gas. Understanding this reaction is crucial for determining the stoichiometric relationships in the lab.

Objectives of the Alka Seltzer Stoichiometry Lab

The primary objectives of conducting an Alka Seltzer stoichiometry lab include:

1. To observe the chemical reaction: Students will witness the effervescence

of carbon dioxide gas as the Alka Seltzer tablet dissolves in water.
2. To measure reactants and products: Students will quantify the amounts of reactants consumed and products formed.
3. To apply stoichiometric principles: Students will calculate theoretical yields and percent yields based on their experimental data.
4. To develop laboratory skills: This lab provides an opportunity to practice precise measurement, data collection, and analysis.

Lab Procedure

The Alka Seltzer stoichiometry lab involves several key steps:

Materials Needed

- Alka Seltzer tablets
- Water
- Graduated cylinder or beaker
- Balance (scale)
- Stopwatch or timer
- Thermometer (optional)
- Stirring rod
- Notebook for recording data

Steps to Follow

1. Weigh the Alka Seltzer tablet: Use the balance to determine the mass of a single Alka Seltzer tablet. Record this mass in your notebook.

2. Measure the water: Pour a known volume of water (e.g., 100 mL) into the graduated cylinder or beaker and record the volume.

3. Dissolve the tablet: Drop the Alka Seltzer tablet into the water and start the stopwatch or timer immediately. Observe the reaction and record the time taken for the tablet to completely dissolve.

4. Collect the gas: If possible, capture the carbon dioxide gas produced by inverting a beaker over the reaction vessel. Measure the volume of gas produced (if applicable).

5. Record observations: Note any changes in temperature, the color of the solution, and the rate of effervescence.

6. Calculate stoichiometric relationships: Using the data collected, perform calculations to determine the theoretical yield of carbon dioxide gas based on the initial mass of sodium bicarbonate.

Calculations in the Lab

To analyze the results of the Alka Seltzer stoichiometry lab, students will need to perform several calculations:

1. Molar Mass Calculation

Calculate the molar masses of the reactants used in the experiment:

- Sodium Bicarbonate ($NaHCO_3$):
- Na: 22.99 g/mol
- H: 1.01 g/mol
- C: 12.01 g/mol
- O_3: 3 × 16.00 g/mol
- Total: 84.01 g/mol

- Citric Acid ($C_6H_8O_7$):
- C_6: 6 × 12.01 g/mol
- H_8: 8 × 1.01 g/mol
- O_7: 7 × 16.00 g/mol
- Total: 192.13 g/mol

2. Moles of Reactants

Using the mass of the Alka Seltzer tablet, calculate the moles of sodium bicarbonate:

$$
\text{Moles of NaHCO}_3 = \frac{\text{mass of NaHCO}_3}{\text{molar mass of NaHCO}_3}
$$

3. Theoretical Yield of CO_2

Using the stoichiometric ratios from the balanced equation, determine the moles of carbon dioxide produced:

$$
\text{Moles of CO}_2 = \text{Moles of NaHCO}_3 \times \frac{3 \text{ moles of CO}_2}{3 \text{ moles of NaHCO}_3}
$$

Then, convert moles of CO_2 to grams using its molar mass (44.01 g/mol):

$$
\text{Mass of CO}_2 = \text{Moles of CO}_2 \times \text{molar mass of CO}_2
$$

4. Percent Yield Calculation

If experimental data for the actual mass of CO_2 collected is available, calculate the percent yield:

$$
\text{Percent Yield} = \left(\frac{\text{actual yield}}{\text{theoretical yield}}\right) \times 100\%
$$

Answer Key for Common Questions

1. What is the balanced equation for the reaction?
- $3 \text{NaHCO}_3 (s) + \text{C}_6\text{H}_8\text{O}_7 (aq) \rightarrow \text{C}_6\text{H}_5\text{Na}_3\text{O}_7 (aq) + 3 \text{H}_2\text{O} (l) + 3 \text{CO}_2 (g)$

2. What is the molar mass of sodium bicarbonate?
- 84.01 g/mol

3. How many moles of CO_2 are produced from 1 mole of $NaHCO_3$?
- 1 mole of $NaHCO_3$ produces 1 mole of CO_2.

4. If 0.10 g of $NaHCO_3$ is used, what is the theoretical yield of CO_2?
- Calculate moles: $\frac{0.10 \text{ g}}{84.01 \text{ g/mol}} = 0.00119 \text{ moles}$
- Theoretical yield of CO_2: $0.00119 \text{ moles} \times 22.4 \text{ L/mol} = 0.0267 \text{ L} \text{ (at STP)}$

5. What factors can affect the yield of CO_2 obtained in the experiment?
- Temperature, pressure, the purity of Alka Seltzer, and measurement accuracy can all impact the yield.

Conclusion

The Alka Seltzer stoichiometry lab is an engaging and educational experience that reinforces key concepts in chemistry. By understanding the chemical reactions that take place, measuring reactants and products, and applying stoichiometric calculations, students develop a deeper appreciation for the quantitative aspects of chemical reactions. The analysis of experimental data not only enhances critical thinking skills but also prepares students for

future studies in chemistry and related fields. Through careful experimentation and calculation, students gain valuable insights into the world of chemistry, making this lab a cornerstone of the educational experience.

Frequently Asked Questions

What is the purpose of the Alka-Seltzer stoichiometry lab?

The purpose of the Alka-Seltzer stoichiometry lab is to investigate the reaction between sodium bicarbonate and citric acid, allowing students to apply stoichiometric principles to determine the amount of reactants and products formed.

What chemical reaction occurs in the Alka-Seltzer lab?

The reaction between sodium bicarbonate ($NaHCO_3$) and citric acid ($C_6H_8O_7$) produces carbon dioxide (CO_2), water (H_2O), and sodium citrate, following the equation: $NaHCO_3 + C_6H_8O_7 \rightarrow CO_2 + H_2O + Na_3C_6H_5O_7$.

How do you calculate the theoretical yield in the Alka-Seltzer stoichiometry lab?

To calculate the theoretical yield, you first need to determine the limiting reactant using mole ratios from the balanced chemical equation, then use that amount to find the maximum amount of product that can be formed.

What safety precautions should be taken during the Alka-Seltzer stoichiometry lab?

Safety precautions include wearing safety goggles, gloves, and a lab coat, as well as working in a well-ventilated area to avoid inhaling any gases produced during the reaction.

Why is it important to measure the temperature change during the Alka-Seltzer reaction?

Measuring the temperature change is important because it indicates the exothermic nature of the reaction and helps in calculating the enthalpy change, which is a key aspect of understanding the reaction's energy dynamics.

What common mistakes should be avoided when performing the Alka-Seltzer stoichiometry lab?

Common mistakes include not accurately measuring reactants, failing to mix the reactants thoroughly, and miscalculating the mole ratios, which can lead to incorrect conclusions about the reaction's stoichiometry.

Alka Seltzer Stoichiometry Lab Answer Key