

Determination of % yeild essay sample



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Abstract

The main objective of this experiment was to find the mole to mole ratio of $\text{NaHCO}_3(\text{s})$, or sodium bicarbonate, to NaCl , or sodium chloride when it is reacted with excess hydrochloric acid. The result of this was a 1 to 1 ratio. The other main objective, which was similar to the first, was to find the mole ratio of sodium carbonate to sodium chloride reacted with excess HCl . The result of this was a 1 to 2 ratio. The main theory proven in this lab experiment was the topic of percent yield.

Introduction

Stoichiometry is an important topic when dealing with chemistry. It is a very mathematical part of chemistry. It's used to calculate moles, percents, and masses of reactants and products in a chemical equation, according to Park (1996). A common stoichiometry problem gives an amount of a reactant and asks how much of the product will be formed. The same source explains that in a mass-to-mass problem, the first step is balancing the equation. Next, the mass is converted to moles using the molar mass of the given substance in the formula $n = m/\text{GFM}$. A mole ratio is then used to convert the moles of the known to the moles of the unknown. Finally, the moles are converted to mass using the formula $n = m/\text{GFM}$.

In a chemical equation, there are two sides. The chemicals on the tail end are called the reactants and the chemicals on the other side are called products. An example of this given by Coefficients (2008) is $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. In this example, " $2\text{H}_2 + \text{O}_2$ " is the reactants and " $2\text{H}_2\text{O}$ " is the product. Also, " \rightarrow " is the sign for "yield." The big 2s in front of H_2 and H_2O

are called coefficients. In this case, the first 2 indicates that there are 2 molecules of H_2 , which also means that there are 4 atoms of hydrogen in the reactant part of the equation. The other 2 signifies that there are 2 molecules of H_2O as the product. This means that every molecule of H_2O that contains 2 atoms of hydrogen contains 4 hydrogen atoms and 2 oxygen atoms. According to Chemistry Formulas (2005), the subscripts are used to signify the number of atoms of an element in a compound. In this example, O_2 means that there are 2 atoms of oxygen.

To balance an equation, How can (n. d.), says that an element inventory is first made. For example, if there was the equation $H_2 + O_2 \rightarrow H_2O$, it would be written down that on the left side there are 2 hydrogen and 2 oxygen, and on the right side there are 2 hydrogen and 1 oxygen. This is determined by the subscripts. Next, the guess and check method is used to determine the correct coefficients. When doing this, the inventory is updated.

According to Law Of (n. d.), the law of conservation of mass is a law that says that the mass of the reactants will always equal the mass of the products. Therefore, mass is neither gained nor lost in a chemical equation.

Chemical reactions don't always produce the theoretical amount of the product, as stated by Volland (2005). Therefore, a percent yield equation is used. The equation for percent yield is: $\%yield = (\text{actual mass of product} / \text{predicted mass of product}) \times 100$.

A main objective in this lab is to find the mole-to-mole ratio of sodium bicarbonate to sodium chloride when sodium bicarbonate is reacted with excess HCl. Another main objective is to find the mole-to-mole ratio of

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sodium carbonate to sodium chloride when sodium carbonate is reacted with excess HCl. A minor objective is to use the percent yield equation. A second minor objective is to find the actual mass and moles produced of NaCl.

The theoretical mole ratio of each reactant to the product of NaCl in the first reaction will be to 1 to 1 because the equation balanced out is $\text{NaHCO}_3(\text{s}) + \text{HCl}(\text{aq}) \rightarrow \text{CO}_2 + \text{H}_2\text{O}(\text{l}) + \text{NaCl}(\text{s})$. For the second reaction, the mole ratio of each reactant to the product of NaCl will be 1 to 2 because the balanced equation is $\text{Na}_2\text{CO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CO}_2 + \text{H}_2\text{O}(\text{l}) + 2\text{NaCl}(\text{s})$.

Methods

1. Measure and record the mass of your clean dry evaporating dish + watch glass (assembled together with the watch glass acting as a cover on top of the evaporating dish).
2. Carefully add 0.3 - 0.4 g of solid sodium bicarbonate (NaHCO_3) to the evaporating dish. Do not do this over the balance! Then measure and record the mass of the evaporating dish + watch glass + NaHCO_3 .
3. Obtain about a 5-mL quantity of hydrochloric acid (HCl) in your small beaker. Then using your dropper pipette, add the HCl drop by drop to the sodium bicarbonate in the evaporating dish. The reaction will be evident by the bubbling that takes place. Gently mix the reactants after every 3-4 drops of HCl. Continue adding HCl until the bubbling stops and all of the NaHCO_3 is dissolved - this indicates that the reaction is complete.

4. Assemble the stand, ring clamp and wire gauze apparatus for heating as shown in the figure below. Cover the evaporating dish with the watch glass and place it on the wire gauze.
5. Gently heat the solution in the covered evaporating dish with a Bunsen burner flame in order to remove the water generated in the reaction (as well as any excess HCl present). The flame should be adjusted to a lower temperature and wafted under the evaporating dish constantly. Continue heating until the contents are completely dry. Note that the watch glass cover should also be dry!
6. After allowing the evaporating dish to cool to room temperature, measure and record the mass of the evaporating dish + watch glass + residue (NaCl).
7. Repeat steps 1 to 6 with a 0.3 - 0.4 g sample of sodium carbonate (Na₂CO₃).

Results

Calculations: Appendix A

Table #1: Experimental and Theoretical Mass and Moles Produced from NaHCO₃

Mass of NaHCO₃ reactant

Moles of NaHCO₃ reactant

Theoretical Moles of NaCl that should have been produced (ratio)

Theoretical Mass of NaCl that should have been produced (calculated)

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Actual (exp) Mass of NaCl Produced

Actual (exp) Moles of NaCl Produced

% Yield

0.33 g

0.0039 mol

0.0039 mol

0.23 g

0.29 g

.0049mol

13%

This table shows the mass and moles of the NaHCO₃ reactant. It also shows what should have been produced and what was actually produced of NaCl. Finally, it shows the percent yield of the product NaCl, which was 13%.

Table #2: Experimental and Theoretical Mass and Moles Produced from Na₂CO₃

Mass of Na₂CO₃ reactant

Moles of Na₂CO₃ reactant

Theoretical Moles of NaCl that should have been produced (ratio)

Theoretical Mass of NaCl that should have been produced (calculated)

Actual (exp) Mass of NaCl Produced

Actual (exp) Moles of NaCl Produced

% Yield

0.77 g

0.0073 mol

0.015 mol

0.88 g

0.75 g

0.013 mol

72%

This table shows the mass and moles of the Na_2CO_3 reactant. It also shows what should have been produced and what was actually produced of NaCl. Finally, it shows the percent yield of the product NaCl, which was 72%.

Discussion

The main problem of this lab experiment was to figure out what the mole-to-mole ratio of sodium bicarbonate to sodium chloride when sodium bicarbonate is reacted with excess HCl. First, sodium bicarbonate was put on weighing paper and weighed on an electronic scale. It measured out to be 0.

33 g. (On Table #1, this was listed under " Mass of NaHCO₃ reactant".) Next, it was placed in an evaporating dish and a watch glass was placed over it. Then the watch glass and evaporating dish were measured together on the scale, measuring 51. 04 g. The Na₂CO₃ was then dissolved in hydrochloric acid and heated over a Bunsen burner until the water and excess HCl were evaporated out. The residue on the watch glass was then measured by weighing the watch glass, evaporating dish, and residue all together. This measured 51. 33 g, and 51. 04 g was subtracted from this to get 0. 29 g.

There was a 13% yield. This was low, and was probably due to many possible error sources. One possible error source could have been that the scale wasn't zeroed out before measuring the sodium bicarbonate and or the watch glass and evaporating dish. This would have lead to the wrong measurements being put into the calculations, bringing incorrect results. Another possibility for wrong measurements would have been if the sodium bicarbonate were added to the evaporating dish over the balance because some of the sodium bicarbonate could have spilled onto the balance. Another error source could have been that the solution wasn't gently heated. This could have caused reactions to happen differently because the water and excess hydrochloric acid would be evaporated in a shorter span of time. Also, if it wasn't heated until the contents were completely dry, there would have been left over water and HCl, causing wrong results.

The common stoichiometry equation, $n = m/GFM$, was used to find most of the information in Table #1. In a mass-to-mass problem, the first step was balancing the equation. Next, the mass was converted to moles using the molar mass of the given substance in the formula $n = m/GFM$. A mole ratio

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was then used to convert the moles of the known to the moles of the unknown. Finally, the moles were converted to mass using the formula $n = m/GFM$. Percent yield was found by using the equation $\%yield = (\text{actual mass of product} / \text{predicted mass of product}) \times 100$.

The hypothesis was correct. The mole ratio of each reactant to the product of NaCl in the first reaction was be to 1 to 1 due to the fact that the balanced equation was $\text{NaHCO}_3(s) + \text{HCl}(aq) \rightarrow \text{CO}_2 + \text{H}_2\text{O}(l) + \text{NaCl}(s)$. For the second reaction, the mole ratio of was be 1 to 2 because the balanced equation was $\text{Na}_2\text{CO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CO}_2 + \text{H}_2\text{O}(l) + 2\text{NaCl}(s)$.

All objectives were met. The main objectives, which were to find the mole ratios of sodium carbonate and sodium bicarbonate when reacted with excess hydrochloric acid, were accomplished. The percent yield equation was successfully used, which was a minor objective. Evidence of this is in Table #1. The second minor objective, which was to find the actual mass and moles of NaCl produced, was also met. There is also evidence of this in Table #1. In conclusion, this lab experiment was successful.

Results

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