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1st hour

Determining the Empirical Formula from a Synthesized Compound

Purpose:

The purpose of this lab was to measure the mass of the reactants consumed during a chemical reaction and use the data to determine the ratio of the reacting masses. Then, form the resulting products to find an empirical formula.

Background:

Law of definite proportions: Any given chemical compound will always contain the same proportion of elements by mass.
Empirical formula: The simplest integer ratio of the relative number of atoms in a compound.
Molecular formula: The actual number of each type of atoms present in one molecule.

Equations:
$3\,Mg\,(s) + N_2(g) \rightarrow Mg_3\,N_2$
This equation shows the side reaction that occurs due to the synthesis of Nitrogen and Magnesium.
$Mg_3\,N_2 + H_2O \rightarrow Mg(OH)_2 + NH_3$
Heat is required for the reaction in order to get rid of the side product, and $Mg(OH)_2$ can be formed by adding water to the side product. This represents a double replacement equation with Magnesium Nitride and water.
$2\,Mg(OH)_2 \rightarrow MgO + H_2O$
The ammonia that was produced in the prior equation is a gas, and it escapes leaving only the $Mg(OH)_2$. By heating the solid, it will decompose to form two separate compounds. Magnesium hydroxide is dissociating into Magnesium oxide and water.

Procedure:

1) Examine the crucible to ensure that there are no cracks that could ruin your experiment.
2) Wash the crucible then heat it and the lid for 5 minutes in order to get rid of contamination. After cooling, weigh the dish and record the mass.
3) Clean the piece of Mg ribbon with sandpaper and coil the ribbon. Then,place it into the crucible.
4) Heat the crucible with the lid tilted to allow the oxygen inside. The heating process should begin with low heat and gradually work up to high heat.

5) Take the crucible off the heat and allow it to cool for at least 10 minutes to ensure that the dish is not too hot for the balance and there are no air currents that could affect the data.
6) Add 5 drops of water into the crucible and repeat the heating process. Wait for the crucible to sufficiently cool off and weigh the results. Record your results after you weigh the final product.

Data:

Crucible	14.8574 g
Crucible with Magnesium	15.1816 g
Heated crucible with Magnesium	13.3086 g

Calculations:

Mass of Magnesium used:
15.1816 g - 14.8574 g = 0.3242 g

Mass of the product:
15.3086 g - 14.8574 g = 0.4512 g

Mass of oxygen reacted:
15.3085 g - 15.1816 g = 0.1269 g

Number of moles of Magnesium:
$\frac{0.3242\ g}{24.3\ g/mol}$ = 0.0133 moles of Mg

Number of moles of Oxygen:
$\frac{0.1269\ g}{16.0\ g/mol}$ = 0.00793 moles of O

Ratio of the number of moles of Magnesium to Oxygen:
$\frac{0.0133\ mol\ Mg}{0.00793\ mol\ O}$ = 1.68:1 moles

Error Analysis:

The ratio for Magnesium to Oxygen should be a 1:1 ratio; however, the ratio from this data was 1.68:1 moles. The percent error is calculated below:

$$\frac{|1\ mol\ mg - 1.68\ mol\ mg|}{1 mol\ mg} \times 100 = 68\%$$

There are many possible reasons that our error analysis is so high. The main one being the time constraints. Although the lab indends for the experiment to be executed at least 3 times to collect accurate data, the time period that we were given did not allow for the groups to do the experiment more than once. Therefore, the data that we collected the first time could have been inaccurate, but the group would not have known because we could not re-do the experiment. Not only that, but the time also could have prevented the crucible from cooling down sufficiently. Addressed in the pre-lab questions, it is necessary to ensure that the crucible is cooled so the air currents do not cause a weight fluctuation. However with the time constraints, the crucible could have not cooled off enough and the air currents could have caused data to be inaccurate. If I were to do this experiment again, I would make sure I have enough time to do the experiment 3 times and allow the crucible to cool off properly to ensure an accurate reading.

Discussion/Conclusions:

An empirical formula is used to represent the lowest whole number ratio of atoms of the elements in the chemical compound. This can be determined by converting the mass of each element into moles by using the molar mass from the periodic table. Then divide each mole value by the smallest number in common of moles calculated, and round the answer to the nearest whole number. The numbers you calculate become the values you put in your empirical formula. If you calculate a number with a decimal, you must multiply the entire formula to get a whole number. In the classroom, we have been learning to solve chemistry problems without the use of a calculator. This has proven to be challenging for many because we are not used to solving mathematical equations without a calculator. Empirical formulas have been the main resource we use in order to determine what the correct answer is since it provides us with the lowest ratio between the elements. Being able to use the formula has allowed us to solve problems that ask to calculate a specific number of moles or mass. Some of the questions include being given the empirical formula and asked to determine the number of moles needed to produce a specific compound. Others include simply using the formula to calculate what the lowest mole ratio is. The empirical formula could be used in the real world when you are determining the quantity of something. For example, you are in a large room and you count that there are 20 women and 30 men, from this information your molecular formula would be $W_{20} M_{30}$. By using the empirical formula, you can simplify it to $W_2 M_3$, which means for every 2 women there are 3 men. Without the knowledge of calculating the formula, you would have a harder time trying to determine the ratio between the two genders. The empirical formula is very useful inside and outside of the classroom because it allows for people to solve difficult problems sufficiently and without a calculator.