Determination of a Simplest Formula

Introduction

An important use of the MOLE CONCEPT is in the determination of the SIMPLEST FORMULA of a compound. In this experiment, you will take a known mass of MAGNESIUM METAL and will convert it to MAGNESIUM OXIDE by heating in air. By subtracting the mass of metal initially taken from the mass of magnesium oxide present after the heating is completed, you can determine the mass of oxygen in the compound. From knowledge of the mass of magnesium initially taken, and the mass of oxygen gained from the air, it is a simple matter to find the molar ratio in which the elements combine. This gives us the simplest formula of the compound.

$Mg(s) + ½\ O_2(g) \rightarrow MgO(s)$

Supplies

Crucible and cover; (CAUTION: The crucible and cover are FRAGILE) clay triangle; magnesium metal

Note

For meaningful results in this experiment, it is crucial that you WEIGH CORRECTLY, and with the correct PRECISION. The balances in our laboratories can weigh to the nearest THOUSANDTH of a gram (0.00l g). NO LESS PRECISION IS ACCEPTABLE!

CHEMICALS

Magnesium metal—Flammable solid

Procedure

CAUTION! IF MAGNESIUM METAL IS HEATED TOO STRONGLY IN AIR, IT WILL IGNITE PRODUCING AN INTENSELY BRIGHT FLAME (WHICH IS DAMAGING TO THE EYES). HEAT SLOWLY, WITH A SMALL FLAME, TO AVOID IGNITING THE MAGNESIUM, AND SPATTERING OF THE PRODUCTS. WEAR SAFETY GLASSES AT ALL TIMES!!

Obtain a crucible and cover. THE CRUCIBLE IS EXTREMELY FRAGILE: BE CAREFUL WITH IT. Wash it out with tap water and wipe with a towel to remove any loosely held solids.

From this point on, handle the crucible only with "crucible tongs" from your locker.

Set up a clay triangle that fits your crucible on a large metal ring on a ring stand. Heat the crucible and cover in the full heat of the burner flame for 5 minutes.

After heating, allow the crucible to cool for 5 minutes. Using the tongs, bring the crucible and cover to the balance and weigh (to nearest 0.001 g). Record the weight on the lab report page.

Add between 0.250 and 0.350 g of magnesium turnings to the crucible. Reweigh the crucible and contents. The weight of the crucible at this point, minus the weight of the empty crucible, gives the weight of magnesium used in the experiment.

Return the crucible to the clay triangle, and slowly begin to heat the crucible. TILT THE COVER of the crucible at an angle, so that the crucible's contents are slightly exposed to the air. If the contents begin to smoke greatly, REMOVE the heat and CLOSE THE COVER on the crucible (the "smoke" is the product of the reaction—magnesium oxide—which will be lost if you do not cover and stop heating).

Continue heating the magnesium until "smoke" no longer forms, then carefully remove the cover, and heat the crucible strongly for 3 to 4 minutes. The contents of the crucible should now be grayish/white, with perhaps a small amount of green.

Allow the crucible to COOL COMPLETELY to room temperature.

When the crucible is completely cool, add 5 to 6 drops of water. An additional product is magnesium nitride. Adding water converts the magnesium nitride to magnesium oxide and ammonia.

Begin heating the crucible slowly with a small flame—a small flame must be used to avoid splattering of the contents. After all the water has been evaporated from the crucible, heat the crucible with a full flame for 3 to 4 minutes. Allow the crucible to COOL COMPLETELY to room temperature.

When the crucible has cooled completely, weigh the crucible and cover to the nearest 0.001 g. The weight of the crucible now, after heating, minus the weight before heating, represents the weight of oxygen consumed by the magnesium in the reaction.

Dispose of your magnesium oxide product in the WASTE Magnesium Oxide bottle.

REMEMBER TO TURN IN THE YELLOW COPY OF YOUR LAB NOTEBOOK TO YOUR TA.

Calculations

1. Calculate the number of moles of magnesium that you used in the experiment.

2. Calculate the number of moles of oxygen that the magnesium consumed during the reaction.

3. Calculate the RATIO of how many moles of oxygen are consumed per mole of magnesium used.

   Given that the "correct" molar ratio for magnesium oxide is l.00, calculate the "error" in your experiment:

$$\% \text{ Error } = \frac{(\text{your ratio - theoretic al ratio})}{\text{theoretica l ratio}} \text{ x } 100$$

Determination of a Simplest Formula
Report Sheet (40 Points)

Name _____ Lab Day _____

Instructor _____ Date _____

(a) Weight of empty crucible _____

(b) Weight of crucible + magnesium _____

(c) Weight of magnesium in crucible _____

(d) Weight of crucible after heating _____

(e) Weight of magnesium oxide present _____

(f) Weight of oxygen absorbed by magnesium _____

(g) Moles of magnesium used _____

(h) Moles of oxygen absorbed _____

(i) Ratio of magnesium/oxygen _____

(j) % error in experiment _____

Determination of a Simplest Formula
Post-Lab Questions (30 Points)

Name _____ Lab Day _____

Instructor _____ Date _____

1. An analysis shows that 2.97 g of iron metal combines with oxygen to form 4.25 g of an oxide of iron. What is the empirical formula of the compound?

2. An oxide of copper is decomposed forming copper metal and oxygen gas. A 0.500 g sample of this oxide is decomposed, forming 0.444 g of copper metal. What is the empirical formula of the copper oxide?

more questions on other side

3. Why should crucible tongs, and not fingers, always be used for handling the crucible and lid after the initial heating.?

4. When the magnesium is not allowed sufficient oxygen, some magnesium nitride, Mg_3N_2, forms.

   A. Write the balanced reaction that occurs when water is added to magnesium nitride.

   B. If the Mg_3N_2 is not decomposed, will the reported magnesium to oxygen ratio be high or low? Explain. Hint: The Mg:N mass ratio is 1:0.38 and the Mg:O mass ratio is 1:0.66.

Determination of a Simplest Formula
Preliminary Questions (10 Points)

Name _____ Lab Day _____

Instructor _____ Date _____

1. Two grams of magnesium is heated as in this experiment, producing 3.33 g of magnesium oxide. Calculate:

   A. The moles of magnesium present

   B. The moles of oxygen present in the magnesium oxide

   C. The molar ratio in which magnesium and oxygen have combined

2. When the magnesium is not allowed sufficient oxygen, some magnesium nitride, Mg_3N_2, forms. How does one decompose any magnesium nitride?