Lab 2 - Empirical Formula of Magnesium Oxide

GOAL AND OVERVIEW

The quantitative stoichiometric relationships governing mass and amount will be studied using the combustion reaction of magnesium metal. Magnesium is reacted with oxygen from the air in a crucible, and the masses before and after the oxidation are measured. The resulting masses are used to calculate the experimental empirical formula of magnesium oxide, which is then compared to the theoretical empirical formula. A crucible and Bunsen burner will be used to heat magnesium metal to burning.

Objectives of the Data Analysis:

Determine the expected formula for the ionic oxide expected when Mg reacts with O_2

Find the theoretical and actual yields of MgO

Evaluate results using stoichiometry and error analysis

PRELAB

Write a purpose for this lab

Report the safety data for all chemicals used in this lab (magnesium).

REACTIONS

Generally magnesium will burn to produce magnesium oxide

$$2\ Mg(s) + O_2(g) \rightarrow 2\ MgO(s)$$

However, in an excess of nitrogen some magnesium will produce magnesium nitride

$$3\ Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$$

Adding water to the reaction

$$MgO + Mg_3N_2 + H_2O \rightarrow MgO + Mg(OH)_2 + NH_3$$

$$MgO + Mg(OH)_2 \rightarrow MgO + H_2O$$

PROCEDURE

1. Fire the empty crucible and lid for about 3 minutes to remove water, oils, or other contaminants and to make sure there are no cracks. The bottom of the crucible should glow red-hot for about 20 seconds. Remove the flame and cool the crucible with lid. Always take the mass of the crucible with the lid on.
2. Record the mass of crucible to ±0.0001 g once it has cooled. Do not handle it with your hands.
3. Obtain about 0.3 g (35 cm) magnesium ribbon (do not handle the ribbon with your hands). Fold the ribbon to fit into the bottom of the crucible.
4. Record the mass of the magnesium ribbon and crucible to ±0.0001 g.
5. Place the crucible securely on the clay triangle. Set the lid ***slightly*** off-center on the crucible to allow air to enter but to prevent the magnesium oxide from escaping.
6. Place the Bunsen burner under the crucible, light it, and brush the bottom of the crucible with the flame for about 1 minute; then, place the burner under the crucible and heat strongly.

7. Heat until all the magnesium turns into gray-white powder (probably around 10 minutes).
8. Stop heating and allow the crucible, lid and contents to cool.
9. Add about 1 mL (~10 drops) of deionized water directly to the solid powder. Carefully waft some of the gas that is generated toward your nose, but ***be very careful***. Record any odor.
10. Heat the crucible and contents, with the lid slightly ajar, ***gently*** for about 2 minutes and then strongly for about another 5 minutes.
11. Allow the crucible to cool and then record the mass of the crucible and contents to ±0.0001 g.

REPORTING RESULTS

Complete your lab summary and report the following information.

Results

Mass of crucible
Mass of crucible + Mg
Mass of crucible after final heating

Calculate- Show sample calculations
mass of Mg metal used to ±0.0001 g
theoretical yield of MgO from reaction: $Mg(s) + 1/2\ O_2(g) \rightarrow MgO(s)$to ±0.0001 g
mass of oxide product formed to ±0.0001 g
mass of O incorporated (difference of MgO and Mg) ±0.0001 g
mole ratio of Mg-to-O (four significant figures each)
empirical formula of the oxide (lowest whole-number subscripts)
percent by mass of Mg and O in the oxide (four significant figures)
percent yield of $Mg + ½\ O_2 \rightarrow MgO$ (actual yield/theoretical yield) × 100% (four significant figures)

Discussion/Conclusions

How does your experimental empirical formula compare to the theoretical empirical formula — do they match?
What are primary sources of experimental error?
How would factors such as incomplete conversion of Mg_3N_2 to MgO or residual $Mg(OH)_2$ in the product affect your results?