Empirical Formula of a Magnesium Oxide

SCC283

Introduction and Background

When magnesium and oxygen are heated together, they readily undergo a chemical change (reaction):

$$\text{magnesium} + \text{oxygen} \rightarrow \text{magnesium oxide} \tag{1}$$

If magnesium is heated in open air, its reaction with oxygen is rapid and spectacular. The metal catches fire, burning with an intense white flame and with production of white smoke. (The metal has been used in flares to provide light for night-time military operations.) We can slow down the reaction by limiting the supply of oxygen that reaches the magnesium; we do that by putting a cover on the crucible that contains the magnesium sample.

From the masses of magnesium and oxygen that combine, we can calculate the empirical formula of magnesium oxide. Magnesium is such an active metal that it reacts with the relatively inactive element nitrogen:

$$\text{magnesium} + \text{nitrogen} \rightarrow \text{magnesium nitride} \tag{2}$$

This side reaction can be *reversed* by adding water to the crucible to allow the following reactions:

$$\text{magnesium nitride} + \text{water} \rightarrow \text{magnesium hydroxide} + \text{ammonia} \tag{3}$$

$$\text{magnesium hydroxide} \rightarrow \text{magnesium oxide} + \text{water} \tag{4}$$

Objective

Experimentally determine the empirical formula of the magnesium oxide formed when magnesium metal is reacted with oxygen gas.

Procedure

1. Wear chemical safety goggles at all times when the sample is being heated. Tie back long hair.
2. Clean a crucible and lid, rinsing thoroughly with deionized water as a last step. (It will not be possible to get a used crucible completely clean.) Dry the crucible and lid with a paper towel. Check the crucible for cracks.
3. Place the clean, dry crucible and lid on a clay triangle on a ring on a ring stand and heat strongly with a Bunsen burner for 5 minutes to remove any volatile material
4. While the crucible is heating, use sandpaper to thoroughly clean a piece of Mg ribbon (approximate mass 0.3 g) to remove any oxide coating. Avoid handling the ribbon with your fingers; this will leave deposits on the Mg ribbon.
5. Using crucible tongs remove the crucible and lid from the clay triangle and place them on your wire gauze to cool.
6. Allow the crucible and lid to cool completely to room temperature and then weigh them together. Handle the crucible with tongs, so you do not leave any deposits from your fingers.
7. Coil the Mg ribbon very loosely and place it inside the crucible at the bottom. Put the lid on the crucible and then weigh the crucible with Mg.
8. Place the lid on the crucible. Heat the crucible gently for 5 minutes. (Think about which part of the Bunsen burner flame is best for heating gently.) Use your crucible tongs to lift the cover slightly every 30 seconds to admit air. If the Mg starts glowing brightly when the cover is lifted, quickly cover the crucible, remove the Bunsen burner, and wait one minute before continuing to heat.
9. Heat the covered crucible strongly for 15 minutes, lifting the cover occasionally.
10. Lift the lid and look at the ribbon to see whether it has become a whitish ash. If the ribbon still has its original color, reheat for 10 more minutes. Continue heating, as necessary, to completely react the ribbon, then allow the crucible to cool.
11. To the contents of the cooled crucible, add 10 drops of deionized water.
12. Partially cover the crucible (leave a slight crack) and heat gently for 2 minutes, then heat strongly for 10 minutes. Allow the crucible and contents to cool to room temperature.
13. Weigh the crucible and contents (magnesium oxide).
14. Reheat strongly (5-10 minutes), cool completely and weigh. Dry the magnesium oxide to a constant mass, repeating the heating until the mass is constant to within 0.2 g.

Calculations and Analysis

Name and Block: _____

1. Data collected:

2. Mass of magnesium:

3. Mass of magnesium oxide:

4. Mass of oxygen that reacted with Mg.

5. Moles of Mg.

6. Moles of oxygen.

7. Experimental empirical formula of magnesium oxide.

8. In this experiment you determined the mass of oxygen (that combined with a weighed mass of magnesium) by subtraction: mass of product minus mass of original magnesium = mass of oxygen that combined. As a result of this procedure, anything that was in the crucible at the end of the experiment, along with the MgO product, would cause an error in the figure that is recorded as "mass of oxygen". Explain what error would occur.