SYNTHESIS OF MAGNESIUM OXIDE

OBJECTIVES FOR THIS EXPERIMENT

The student will be able to do the following:

1. Heat a solid using a Bunsen burner, a ring and a crucible.
2. Calculate an experimental empirical formula for magnesium oxide.
3. Calculate the theoretical mass of magnesium oxide from an experimental mass of magnesium.
4. Calculate the percent yield from the experimental and theoretical masses of magnesium oxide.
5. Calculate both experimental and theoretical percent compositions of magnesium oxide.
6. Calculate percent error from the experimental and theoretical mass of magnesium oxide.

BACKGROUND TO THE EXPERIMENT

When you heat magnesium to a high temperature, it reacts with oxygen in the air to form magnesium oxide.

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

Simultaneously, magnesium reacts with the nitrogen in the air to form magnesium nitride.

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

In this experiment, we are interested in making only the oxide and not the nitride. To accomplish this, we add water to the mixture of magnesium oxide and magnesium nitride. Upon heating, the nitride reacts with the water to form magnesium hydroxide and ammonia gas. The ammonia is driven off in the heating. The magnesium hydroxide is heated to high temperature and decomposes to magnesium oxide and water. Thus, at the end of the experiment, all of the magnesium has been converted to the desired product, magnesium oxide.

$$Mg_3N_2(s) + 6H_2O(l) \rightarrow 3Mg(OH)_2(s) + 2NH_3(g)$$

$$Mg(OH)_2(s) \xrightarrow{\Delta} MgO(s) + H_2O(l)$$

PROCEDURE

1. Clean a crucible thoroughly with tap water and rinse it with distilled water. After washing, handle the clean crucible with your crucible tongs.
2. Dry the crucible and cover by heating them strongly for 5 minutes. The bottom of the crucible should be at the tip of the inner core of the flame. Be sure the valve on the Bunsen burner is wide open and turn the gas up high enough to give a steady flame. The bottom of the crucible should glow red-orange.
3. Transfer the crucible and cover to your tile and allow them to cool to room temperature.
   a. Be sure to handle them with your crucible tongs. They are very hot, and you do not want to transfer your fingerprints.
   b. While you are waiting, you can begin to set up your calculations.
4. Weigh the crucible and cover accurately to 0.0001 g and record the mass on your data sheet. (Be sure they are cool. If they are too hot, your mass will be incorrect. The display of the balance will give a value that is too low. You will know if the crucible and cover are too hot, because the mass displayed will continually go up.)
5. Obtain a strip of magnesium ribbon about 3-4 cm long. Clean it with steel wool. After cleaning, handle the magnesium strip with your forceps.
6. Cut the magnesium ribbon into pieces small enough to lie flat on the bottom of the crucible. Place the pieces in the crucible.

7. Measure and record the mass of the crucible, cover, and magnesium to 0.0001 g.
8. Cover the crucible with the lid and heat it gently for 5 minutes.
9. After 5 minutes, lift the lid slightly with a pair of tongs or forceps to introduce a small amount of air. If the magnesium begins to burn brightly, you have added too much air, and the lid should be replaced immediately.
10. Continue heating and lifting the lid until the sample no longer glows brightly when you lift the lid. The magnesium should have changed completely to ash at this point.
11. Remove the lid and place it upside down on your tile.
12. Lower the crucible to the tip of the inner core and heat for 5 minutes. The bottom of the crucible should glow red-orange.
13. Allow the sample to cool.
14. Carefully add a enough water to cover your product. (Although the sample can be warm when you add the water, you can lose part of the sample from the splattering if it is too hot.)
15. Heat the crucible, cover, and sample gently with the lid covering the sample for about 5 minutes.
16. Lower the crucible to the tip of the inner core, remove the lid, and heat strongly for 5 minutes. The bottom of the crucible should glow red-orange.
17. Allow the apparatus to cool and then weigh the crucible, cover, and product.
18. Check to see if you need to repeat steps 14-17 by doing the following.
    a. Calculate the mass of magnesium used.
    b. Calculate the mass of magnesium oxide formed.
    c. Calculate the theoretical maximum mass of magnesium oxide that would be formed from your mass of magnesium.
    d. Calculate your percent yield.

$$\text{Percent yield} = \frac{\text{actual yield MgO}}{\text{theoretical yield MgO}} \times 100\%$$

    e. If your percent yield is over 95%, go to step 19.
    f. If your percent yield is less than 95%, reweigh your sample. You might have weighed it when it was too hot, giving a mass too low.
    g. Recalculate your percent yield.
    h. If your percent yield is still less than 95%, check with your instructor.
19. Calculate the mass of oxygen that combined with the magnesium.
20. Using the masses calculated above, calculate the empirical formula and compare it to the actual empirical formula which is MgO.
21. Calculate both the experimental and theoretical percent composition of magnesium oxide.
22. Calculate the percent error for your experiment by comparing the experimental mass of magnesium oxide with the theoretical mass of magnesium oxide.

$$\text{Percent error} = \frac{\left|\text{theoretical mass MgO - experimental mass MgO}\right|}{\text{theoretical mass MgO}} \times 100\%$$

NAME _____

REPORT SHEET FOR THE SYNTHESIS OF MAGNESIUM OXIDE

DATA

Mass of the crucible and cover	
Mass of crucible, cover and magnesium before heating	
Mass of crucible, cover and product after the first heating with water	
Mass of crucible, cover and product after second heating with water (If necessary)	

CALCULATIONS (Show your work.)

_____ Mass of magnesium used

_____ Mass of magnesium oxide formed

_____ Theoretical mass of magnesium oxide from your mass of magnesium

_____ Your percent yield

_____ Mass of oxygen that combined with the magnesium

_____ Empirical formula of magnesium oxide based on your data

_____ Experimental percent oxygen in magnesium oxide

_____ Experimental percent magnesium in magnesium oxide

_____ Theoretical percent oxygen in magnesium oxide

_____ Theoretical percent magnesium in magnesium oxide

_____ Percent error.