6. Holding the burner in your hand, gently heat the contents of the uncovered crucible by moving the burner slowly back and forth. Avoid spattering. Observe the odor of the vapor given off.

7. When all of the liquid has boiled off, repeat steps 5 and 6.

8. When all the liquid has boiled off a second time, strongly heat the uncovered crucible for 5 minutes.

9. Turn the burner off and allow the crucible and contents to cool. Measure the combined mass of the crucible and contents.

Data:
Mass of empty crucible (dried): 19.0135 g
Mass of crucible and magnesium: [redacted] 19.1138 g
Mass of crucible and magnesium oxide: 19.2801 g

Observations:
* The magnesium ribbon was shiny and grey at first
* After heating, the magnesium oxide became white and dull
* I smelled a little ammonia coming from the crucible after boiling off the water the first time.

Calculations:
1. Calculate the mass of magnesium used:

mass (crucible + Mg) − mass (crucible) = mass (Mg)

19.1138 g − 19.0135 g = 0.1003 g Mg

2. Find the mass of oxygen that reacted:

mass (crucible + magnesium oxide) − mass (crucible + magnesium) = mass (O)

19.2801 g − 19.1138 g = 0.1663 g O

3. Determine the empirical formula of the magnesium oxide compound:

$0.1003\ g\ Mg \times \frac{1\ mol\ Mg}{24.3\ g\ Mg} = 0.0041276\ mol\ Mg$

$0.1663\ g\ O \times \frac{1\ mol\ O}{16\ g\ O} = 0.0104\ mol\ O$

$Mg_{0.004128}O_{0.0104}$

↓

$MgO_{2.519}$

↓

Mg_2O_5

Conclusion Questions:

1. Write and balance the chemical equation for the formation of magnesium oxide from magnesium and oxygen.

$$2Mg + O_2 \rightarrow 2MgO$$

2. Write and balance the chemical equation for the formation of magnesium nitride from magnesium and nitrogen.

$$3Mg + N_2 \rightarrow Mg_3N_2$$

3. Write and balance the chemical equation for the production of magnesium oxide and ammonia from magnesium nitride and water.

$$Mg_3N_2 + 3H_2O \rightarrow 3MgO + 2NH_3$$

4. What is the percentage of magnesium by mass in magnesium oxide?

$$\%\,(Mg)_{\text{in } MgO} = \frac{24.3\ g/mol}{40.3\ g/mol} = 0.6030 = 60.30\%$$

5. How do your results for the empirical formula compare to the actual empirical formula of magnesium oxide (MgO)? Explain.

Compared to the actual empirical formula, the empirical formula we measured has a greater percentage by mass of oxygen, or, equivalently, a lesser percentage by mass of magnesium.

6. Justify any deviation from the theoretical results. (For example, if your ratio was too high or low, cite and explain specific reasons why this might be the case.)

Strangely, our Mg/O ratio was too low. This is most likely caused by my poor memory and failure to record the correct initial mass of the crucible and magnesium. Instead of writing down the mass of the crucible and magnesium while it was on the balance, I attempted to memorize the mass, then run back to my desk to write it down. I probably made a mistake.

7. If you did not heat the magnesium long enough for full reaction of the metal, how would your empirical formula differ? Explain.

If we did not heat the magnesium long enough, and the magnesium did not fully react, we would not form the maximum possible amount of magnesium oxide. This would result in a lower mass of oxygen reacted and a too-low ratio of oxygen to magnesium. The empirical formula would appear to be Mg_xO_y with $y < x$.

8. Suppose 2.033 g of magnesium is reacted according to an experiment similar to the one above. What is the theoretical yield of magnesium oxide?

$$2.033\ g\ Mg \times \frac{1\ mol\ Mg}{24.3\ g\ Mg} \times \frac{2\ mol\ MgO}{2\ mol\ Mg} \times \frac{40.3\ g\ MgO}{1\ mol\ MgO} = 3.37\ g\ MgO$$

(theoretical yield)