### Determining the Empirical Formula of Magnesium Oxide

#### Introduction:

Empirical formula is defined as the simplest whole number ratio of the elements in a compound. The actual formula for the elements in a compound is termed the molecular formula and is the true ratio. For example, hydrogen peroxide has an actual formula of  $H_2O_2$ . The simplest ratio of the elements is  $H_1O_1$  and therefore is the empirical formula.

In this experiment, the reaction between magnesium metal and oxygen gas will be observed. When heated, magnesium reacts readily with oxygen in the air. By determining the mass of the reactants and products in the experiment, one will be able to determine the moles involved in the reaction. Based on the charges predicted from the periodic table, the ratio of the magnesium to oxygen in the compound magnesium oxide should be 1 to 1.

### **Objectives:**

- 1. To determine the empirical formula for magnesium oxide.
- 2. To gain practical experience in developing techniques using a crucible.



FIGURE 13-1 Apparatus for determining empirical formula.

### **Procedure:**

- 1. Support a crucible and cover with a clay triangle and place on a ring stand. Heat the empty crucible with the cover on until the bottom is red hot. Make sure that the inner blue cone of the flame is heating the crucible. This will remove any impurities found in the crucible.
- 2. Remove the heat and allow the crucible to cool for a few minutes. Using crucible tongs, transfer the crucible to the balance and find the mass of the crucible and cover.
- 3. Obtain a 25 cm strip of magnesium ribbon and roll it into a flat coil. Place the loosely coiled magnesium flat against the crucible and weigh the crucible, cover, and magnesium ribbon. It is important that the magnesium ribbon be loosely coiled and in good contact with the bottom of the crucible. If it is not in good contact, there will be difficulty getting the Mg to ignite.

4. Return the crucible to the clay triangle. The crucible should be positioned so that its bottom is just above the tip of the inner blue cone of the flame. With the lid off, heat the crucible until the magnesium sparks and begins to smoke. Immediately remove the heat and place the cover firmly on the crucible using the tongs. (It is best if one of the pair of student is in charge of the lid). The lid needs to be held tightly with the tongs and placed over the crucible as soon as any white smoke is observed. Five to ten seconds after the lid is placed on the crucible, it can be lifted slightly. If the magnesium glows (as more oxygen is admitted into the crucible) and smoke forms, the lid should be put back on. This process is repeated until the sample no longer is reacting.

**NOTE:** Safety goggles should be worn when heating the magnesium.

- 5. After the smoke has ceased, continue to heat the crucible until the metal is completely converted to a gray-black residue.
- 6. When the metal no longer sparks, remove the heat and allow the crucible to cool for 5 minutes. Add several drops of distilled water with a dropper pipet to the residue. **NOTE:** Some of the magnesium will react with the nitrogen in the air forming magnesium nitride. The addition of water decomposes any magnesium nitride present releasing ammonia gas.
- 7. Refire to red heat for 5 minutes. Remove the heat and allow the crucible with product to cool for 5 minutes. Transfer the crucible to the balance and find the mass of the crucible and magnesium oxide.

# PreLab Questions:

- 1. Why is it necessary to heat the crucible before weighing it the first time?
- 2. With what element or elements does the magnesium combine when it is heated in the crucible?
- 3. Why is distilled water added to the crucible after the initial heating of the magnesium?
- 4. How can you tell when the reaction is complete for the magnesium?
- 5. What safety precautions must be observed in this experiment?

# Data and Calculations. Include a copy of the data table and calculations in the report.

### Conclusion:

In the conclusion section of the report, analyze the results obtained. The experimentally determined formula for magnesium oxide should be compared with the formula predicted for this compound based on the normal ionic charges for combined magnesium and oxygen. Possible sources of error should be discussed and related to discrepancies between the experimentally determined formula and the predicted formula.

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	Materials	Mass (grams)
1.	Crucible and cover + magnesium ribbon (before heating)	
2.	Empty crucible and cover	
3.	Magnesium Metal Used (#1 minus #2)	
4.	Crucible and cover + Magnesium oxide (after heating)	
5.	Magnesium oxide made in reaction (#4 minus #2)	
6.	Oxygen combined in product (#5 minus #3)	

### Data Table for the Empirical Formula of Magnesium Oxide

## Calculation of empirical formula:

- 1. Determine the moles of magnesium metal used in the reaction. (Convert mass of Mg (#3) into mole.)
- 2. Determine the moles of oxygen combined in the product. (Convert mass of oxygen (#6) into mole.)
- 3. Determine the mole ratio of magnesium to oxygen in magnesium oxide. (Divide by the smallest mole to obtain the mole ratio.)
- 4. What is your empirical formula of magnesium oxide.