Honors Chemistry Lab #11- Experimental Determination of an Empirical Formula

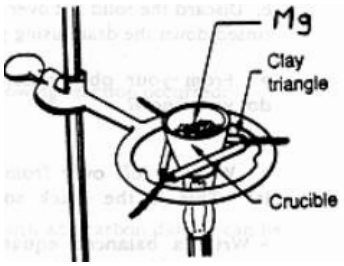
The empirical formula of a compound gives the lowest whole-number ratio of the constituent atoms that is consistent with the mass ratios measured by experiment. In this lab, magnesium will be reacted with oxygen from the air in a crucible, and the masses before and after the oxidation are measured. The resulting masses are used to calculate the experimental empirical formula of magnesium oxide, which is then compared to the theoretical empirical formula. The empirical formula of magnesium oxide, Mg_xO_y, is written as the lowest whole-number ratio between the moles of Mg used and moles of O consumed. This is found by determining the moles of Mg and O in the product; divide each value by the smaller number; and, multiply the resulting values by small whole numbers until you get whole number values. A crucible and Bunsen burner will be used to heat magnesium metal to burning. The addition of heat provides the energy necessary to overcome the activation energy barrier in this exothermic reaction. In this lab investigation you will prepare magnesium oxide, calculate the percent composition of your product, and determine the product's experimental empirical formulas and compare that to the expected empirical formula for the compound.

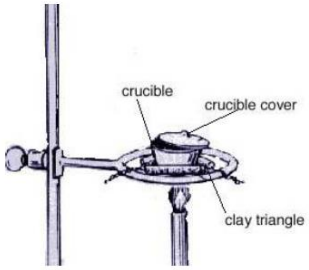
Question: How can I experimentally determine the empirical formula of a substance synthesized through the exploitation of thermodynamically favorable conditions.

Equipment: crucible and cover, tongs, Bunsen burner, clay triangle, ring stand, iron ring, wash bottle, glass stirring rod, 15 cm Mg ribbon, analytical balance, distilled water (dH_2O), lab safety regalia

Procedure:

1. Wash and dry your hands (moisture on your hands will react with the magnesium ribbon).
2. Record the mass of a clean, dry crucible and cover.
3. Obtain a piece of magnesium ribbon approximately 15 cm long from your instructor and scrape both sides of the magnesium with the scissor blade to remove corrosion (when the corrosion is removed the Mg will appear shiny = luster). Cut the Mg into very small strips to maximize contact with the bottom of the crucible. Place the magnesium in the crucible and record the mass of the magnesium, crucible, and lid.
4. Place the crucible, cover and magnesium on a clay triangle as shown in the figures below.





5. Adjust the crucible and cover on the clay triangle so that the lid is ajar. This position will allow a steady flow of air into the crucible. Heat the crucible gently for 3 minutes then strongly for 5 minutes. **CAUTION**: *Do not look directly at the burning magnesium.*
6. Allow the crucible to cool for 5 minutes.

ANALYSIS: Show all measurements and calculated numbers in the spaces provided in the data table. (Show units and substance symbol or formula for each measurement taken or number calculated.)

Data Table	**Measurement**
mass of crucible, cover, and Mg before heating	
mass of empty crucible and cover	

mass of magnesium	
mass of crucible, cover and residue after heating	
mass of residue (magnesium oxide produced)	
mass of oxygen	
moles of oxygen in the magnesium oxide residue	
moles of magnesium in the magnesium oxide residue	

Claim: Write your claim based on the data and evidence collected.

Questions and Calculations (questions may be incorporated into your summary sections of ARMS)

Q1. Calculate the percent composition of magnesium oxide (write the formula, balancing the charges of the Mg ion and the O ion, then find the percent composition by mass).

Q2. From your measured value of the mass of residue in your data table, calculate the moles of magnesium and of oxygen in your sample of residue.

Q3. Using the moles calculated above; calculate the empirical formula for your sample of magnesium oxide.

Q4.Using the empirical formula found above, what is its molecular formula if the molar mass is 40.3 g/mol?

Q5. Does the magnesium in your crucible gain or lose mass? Explain.

Q6. How would your final ratio change if not all of the magnesium had reacted?

Q7. Does your calculated formula for magnesium oxide in Q3 match the expected formula? Propose an explanation for why your ratios may more or less than expected.

Q8. Why was heat needed for this reaction to occur? Sketch a graph that could be used to support your explanation.

Q9. What else in the air could the magnesium have reacted with in this lab? How might this impact your experiment data?

Please self-assess your lab report using the STEM journal rubric/checklist.