Name: _____

Law of Definite Proportions

Background: When chemists began measuring starting materials and products of their reactions, they quickly noticed that substances reacted with each other in specific ratios. This suggested that the products of reactions were not simple mixtures of ingredients, but instead were unique combinations, fitting together like pieces of a puzzle.

In this activity, a known mass of magnesium metal will be burned in the presence of excess oxygen, producing magnesium oxide. Because air is about 80% nitrogen gas, a possible reaction that may occur is the combination of magnesium with nitrogen to make magnesium nitride. A mixture of magnesium nitride with magnesium oxide would give a variable product mixture, obscuring any definite proportion. To combat this possibility, the product of the first reaction will be treated with water. Any magnesium nitride will react with water to produce magnesium hydroxide and ammonia. Subsequent heating will evaporate the water and ammonia, and convert magnesium hydroxide to magnesium oxide.

Objective: To verify the law of definite proportions.

Safety: Wear chemical splash goggles. Tie back long hair and beards. Restrain any dangling objects such as lanyards and neckties. Do not view burning magnesium directly: eye injury may result.

Disposal: Place the crucible residue in the nonhazardous waste container.

Materials:

- crucible with cover
- burner and flint
- ring stand and iron ring
- triangle pipe stem (clay triangle)
- stirring rod
- crucible tongs
- ceramic plate
- centigram or electronic balance
- segment of magnesium ribbon
- water

Procedure:

1. Gently heat a crucible to dryness with the Bunsen burner.
2. Transfer the crucible and cover to a clean ceramic plate.
3. After the crucible has cooled, determine the mass of the crucible and cover. Record it in the Data Table.
4. Obtain a specimen of magnesium ribbon from your instructor. Remove any dull oxide coating by rubbing it with steel wool. Coil the ribbon loosely in the bottom of the crucible.
5. Determine the mass of the crucible, cover, and contents. Record it in the Data Table.
6. Place the crucible containing the magnesium on the triangle pipe stem. Place the crucible cover on the crucible slightly ajar. This will allow oxygen to enter.
7. Heat the crucible gently for two minutes.
8. Heat the crucible intensely for an additional ten minutes.
9. Remove the crucible and cover from the pipe stem and set them on a clean ceramic plate.
10. When the crucible has cooled, transfer the cool crucible and cover to a balance and determine the mass. Record the mass in the Data Table.

11. Repeat Steps 6–10.
12. If the difference between successive mass measurements is less than 0.01 g, record the mass as the constant mass. If the difference is greater than 0.0l g, repeat Steps 6–10 again until the mass measurements differ by 0.01 g or less. Record this mass in the Data Table as the constant mass.
13. Add a small amount of distilled water to the product in the crucible. Stir to make a thin paste.
14. Place the crucible on the triangle pipe stem. Place the cover slightly ajar. This will allow ammonia and water vapor to escape.
15. Heat the crucible gently to dryness, and continue heating gently for two minutes more.
16. Heat the crucible intensely for an additional ten minutes.
17. Remove the crucible and cover from the pipe stem and set them on the ceramic plate.
18. When the crucible has cooled, transfer the cool crucible and cover to a balance and determine the mass. Record the mass in the Data Table.
19. Place the magnesium oxide in the non-hazardous waste container. Clean the crucible.
20. Obtain the initial magnesium masses and final product masses from all of the groups in your class. Record them, including the masses you measured, in the Plot Table.
21. On graph paper, make a graph of the final product masses (vertical axis) vs. initial magnesium masses (horizontal axis). Scale the graph so that your plot occupies at least half of each axis. Label each axis, including units. Title your graph.

***Calculations*:** Show your work below. Be sure you retain adequate digits when you calculate moles and ratios of moles. Record all calculated values in the Calculations Table.

1. Determine the initial mass of magnesium metal.

2. Determine the mass of the magnesium oxide product.

3. Calculate the ratio of the mass or magnesium oxide product to the mass of magnesium starting material.

Data Table

mass of dry crucible plus cover	
mass of crucible, cover, and Mg	
mass of crucible, cover, and product (first heating)	
final constant mass of crucible, cover, and product	
final mass of crucible, cover, and dried product	

Calculations Table

mass of Mg reacted (initial mass)	
mass of product	
ratio of product mass to initial Mg mass	

Plot Table

Group	Initial mass	Product mass

Questions:

1. What was the reason to the repeatedly heat the initial product?

2. If the Law of Definite Proportions applies, what should be the relationship between the product mass and initial mass?

3. If the Law of Definite Proportions applies, what should be the shape of a plot of product mass vs. initial mass?

