Law of Definite Composition

Elements are a kind of matter that cannot be decomposed. Compounds are combinations of elements. However, not all combinations of elements are compounds. The combination must be a chemical combination. For example, the combination of nitrogen gas and oxygen gas in air is a mixture. The gases are physically combined and therefore can be mixed in an infinite variety of proportions. Compounds, on the other hand, are special combinations of elements.

The Law of Definite Composition states that the elements that form a compound always combine in the same proportion by mass. The compound water, H_2O, always is a chemical combination of hydrogen and oxygen in a 1:8 ratio by mass. If a mixture of hydrogen and oxygen in some other ratio, say 1:2, were reacted, there would be water formed, but there would also be some unreacted hydrogen, because water always forms in the 1:8 ratio by mass.

In this experiment, you will examine the reaction between magnesium metal, Mg, and the oxygen in the air, O_2. The magnesium will be heated strongly in a crucible for several minutes. The mass of magnesium will be compared with the mass of the material produced.

OBJECTIVES

1. to observe the reaction between magnesium and oxygen
2. to calculate the ratio of mass of product to mass of magnesium
3. to make careful mass measurements that are adequate for appropriate results

MATERIALS

Apparatus

crucible and lid
crucible tongs
medicine dropper
centigram balance
pipestem triangle
ring stand and ring
burner and lighter
wire gauze with ceramic center
sandpaper or emery cloth
safety goggles
lab apron

Reagents

magnesium ribbon
distilled water

PRELAB

Answer questions 1-6 on the Report Sheet.

PROCEDURE

1. Put on your apron and goggles. Hot crucibles and magnesium can cause burns, so use with caution. Handle hot crucibles with tongs and place the hot crucible on the wire gauze to cool.
2. Obtain a piece of magnesium from your instructor. If the surface of the magnesium is not shiny, use a piece of sandpaper or emery cloth to shine the surface.
3. Obtain a clean and completely dry crucible and cover. Find the mass of the crucible and cover and record it on the Report Sheet.
4. Roll the magnesium into a loose coil and place it in the crucible. Find the mass of the crucible, cover, and magnesium. Record it on the Report Sheet.

5. Set up the ring stand, ring, burner, and pipestem triangle as shown in Figure 2B-1. Place the crucible on the pipestem triangle. Begin heating the crucible gradually with the *lid completely on.* Heat slowly by moving the flame around underneath the crucible. Remove the heat temporarily if a large amount of smoke comes out of the crucible.
6. After about four minutes of direct heating with no smoke, remove the lid slightly. Heat the crucible to *redness* for four minutes. Finally, remove the lid completely and heat strongly for four more minutes.
7. Turn off the burner and put the lid back on the crucible. Allow the crucible and cover to cool to a temperature low enough so that you can touch the crucible. Find the mass of the crucible, contents, and cover. Add ten drops of distilled water. Smell cautiously, note any odor. Put the crucible back on the ring-stand setup and heat again for four minutes with the *lid on.* Allow to cool again.
8. Find the mass of the crucible, cover, and product. Record it on the Report Sheet.
9. If enough time remains, reheat the crucible for four minutes, allow it to cool, and again find the mass. If this mass differs by more than 0.03 g from the mass you found in Step 8, repeat this procedure until the masses are within the 0.03-g range.
10. If enough time remains, repeat the whole procedure for a second trial.
11. Clean and put away all of the materials.
12. Wash your hands thoroughly with soap and water, using a fingernail brush to clean under your fingernails.

POST LAB DISCUSSION

The magnesium metal is an element that combines with another element, oxygen gas, to form the compound magnesium oxide. The ratio of the mass of magnesium oxide to the mass of magnesium should be constant for all of your trials, regardless of the mass of magnesium that you started with.

The strong heating insured that all of the magnesium reacted with the oxygen in the air to form magnesium oxide. Since some magnesium nitride (magnesium + nitrogen) could have formed, the addition of water and subsequent heating were done to remove that product from the crucible.

In order to calculate the ratio, you must first find the masses of magnesium oxide alone and of magnesium alone by subtracting the mass of the crucible from the masses that you recorded. The ratio is then calculated by:

RATIO = MASS OF MAGNESIUM OXIDE/MASS OF MAGNESIUM.

Law of Definite Composition

Name _____

Class _____ Date _____

EXPERIMENT 2B REPORT SHEET

PRELAB QUESTIONS

1. If you were to combine 80 g of oxygen with some hydrogen, how much hydrogen would you need to completely use up all of the oxygen? _____
2. Suppose you found that a compound of sodium and chloride was formed in the ratio of 1.54 g of chlorine for each gram of sodium. How much sodium would you need to completely react 45.0 g of chlorine? _____
3. Why is it important to begin the experiment with a clean and dry crucible? _____
   _____
4. What is the purpose of making sure that the outside of the magnesium strip is clean and shiny?
   _____
   _____
5. What elements does the magnesium combine with when it is heated in the crucible? _____
6. In Step 9 of the Procedure, you are asked to reheat the crucible one more time if your two mass readings differ by more than 0.03 g. What is the purpose of the reheating? _____
   _____

RESULTS

	TRIAL ONE	TRIAL TWO
Mass of crucible and cover	_____	_____
Mass of crucible, cover, and magnesium	_____	_____
Mass of crucible, cover, and product (before adding water)	_____	_____
Mass of crucible, cover, and product (second time)	_____	_____

CONCLUSIONS

1. For each of the trials, calculate the following:
   mass of magnesium alone
   mass of magnesium oxide alone
   ratio of mass of magnesium oxide to mass of magnesium
   Show all of your work below and record your results on the next page.

Calculated results

	TRIAL ONE	TRIAL TWO
Mass of magnesium alone	_____	_____
Mass of magnesium oxide alone	_____	_____
Ratio, magnesium oxide:magnesium	_____	_____

2. The accepted ratio for the mass of magnesium oxide to the mass of magnesium is 1.65. Calculate the percent of error for each of your trials by using the formula:

$$\text{PERCENT ERROR} = \frac{\text{(ACCEPTED VALUE} - \text{EXPERIMENTAL VALUE)}}{\text{ACCEPTED VALUE}} \times 100$$

Show your work and record the answers below:

Percent of error =

TRIAL ONE	TRIAL TWO
_____	_____

SYNTHESIS

1. Use your textbook to determine the formula for the magnesium oxide that is formed in this experiment. _____
2. Use the accepted ratio to find the mass of magnesium that would be needed to combine with 16.0 g of oxygen. _____
3. What mass of magnesium oxide would be formed in item 2? _____
4. Suppose you tried to combine 42.0 g of magnesium with 45.0 g of oxygen. How much magnesium oxide would be formed? _____ Would there be any magnesium or oxygen left over? If so, which element and how much? _____