Lab #4: Law of Definite Proportions

Purpose: To increase understanding of and verify the Law of Definite Proportions

Background: In this day and age, we are surrounded by a very sophisticated understanding of chemistry and we take for granted that **atoms** and **compounds** exist. You have known from a very young age that compounds such as water (H_2O) form in definite, unchanging ratios. However, there was a time when the very fact that atoms existed was undetermined.

In the 19th century, the distinction between what was a compound and what was a mixture had not yet been determined. Scientists were struggling to define the concept of atoms and consequently compounds.

A French scientist, Joseph Proust, was the first to observe experimentally that when elements combine to form compounds they always do so in a consistent mass ratio. For example, when water is formed from hydrogen and oxygen, the mass of hydrogen to oxygen is always 1:8 or 1 grams of hydrogen for every 8 grams of oxygen.

An English scientist, John Dalton, emphasized the importance of Proust's discovery when he developed the Modern Atomic Theory. In the Modern Atomic Theory Dalton put forth the concept of an **atom** as the simplest form of nature and stated that for any given element the atoms for that element are identical in size and mass. Furthermore, when atoms come together they form compounds. This they always do so in a *consistent, definite ratio.*

The concept of Definite Proportions was not immediately accepted. A well established scientist, Claude Louis Berthollet proposed that compounds were not definite in nature but rather that they could vary in their composition based on the amounts of reactants (ingredients) present when the compound was formed. Hence, the structure of compounds was taken for granted. Because of his authority, Proust's Law of Definite Proportions was only accepted after much experimentation.

In this lab we will be combining magnesium with oxygen by heating. After an initial ignition in which the magnesium burns brightly, the heat of the Bunsen burner will cause the magnesium to bond with oxygen from the air creating the compound magnesium oxide.

Materials:

Crucible with lid	Magnesium Ribbon	Bunsen burner
Tongs	Clay triangle	Ring stand w/support

Procedure:

Caution: Do not look directly at the burning magnesium. View indirectly. Sustained viewing can cause permanent eye damage!

In this lab, the crucible you are working with will become quite hot and could cause a severe burn if handled improperly. Observe all precautions, especially the ones listed below.

1. Measure and record the mass of both your crucible and your lid separately. Record this data in your data table.
2. Obtain a piece of magnesium ribbon approximately 25 cm long. Roll into a coil. The coil should not be so tight that air cannot reach the inner coils; however, you should be able to fit the entire length into the crucible. Take and record the mass of your magnesium.
4. Over a high flame with a well defined blue cone, heat the **uncovered** crucible on the triangle until the magnesium ignites. Failure to have a well defined blue cone will result in a cooler than necessary flame. As a result your magnesium may not ignite. Caution: Do not inhale the smoke produced. Do not look directly at the white light, it can cause permanent eye damage!!!! When the magnesium begins to burn, remove the burner, and immediately cover the crucible with your lid.
5. After smoke production has ceased, place the burner under the crucible and continue heating for 10 minutes. The lid should remain on at this time. Remove the lid briefly every 2 minutes to ensure the chemical reaction is continuing; you should see glowing if the reaction is still underway. Caution: Do not lean over the crucible.
6. After heating for a total of 10 minutes, carefully lift the lid with your tongs and check the magnesium. It should be wholly converted to a light gray powder, magnesium oxide.
7. Turn off and remove the burner. Allow the crucible to cool completely until it is cool to the touch. This will take several minutes. Be very careful not to burn yourself, as porcelain can get very hot! DO NOT attempt to mass your crucible while it is still hot. This will result in inaccurate data.
8. When cool, measure and record the combined mass of the crucible, crucible lid and magnesium oxide.
9. Return your crucible to the ring stand for a second heating, keeping the lid on. This time you should heat for at least 5 minutes.
10. After this time is up, again turn off the burner and allow the crucible to cool (to the touch). Once it is cool, mass the crucible/lid/magnesium oxide again.

11. If the LAST two masses (after each heating) are within 0.02 g of each other, then your reaction has run to completion and you will record your final mass. If NOT, then run a third heat/cool cycle and mass again.

12. Continue to heat and mass until the last two mass cycles are within 0.02 g of each other. Remember to record your final mass.

13. Follow your teacher's instructions for proper disposal of the materials.

Signature for cleanup _____

DATA TABLE(S): COMPLETE BEFORE COMING TO LAB (USE A RULER)

PRELAB QUESTIONS: COMPLETE PRIOR TO COMING TO LAB

1. State the Law of Definite Proportions.

2. What do we take for granted about the formation of compounds?

3. Before the Law of Definite Proportions was experimentally proven and accepted, what was the accepted belief regarding the formation of compounds?

4. In this lab you will be combining magnesium and oxygen to determine their mass ratio. In order to tes the Law of Definite Proportions, we will compare your results with the rest of the class. Explain why.

5. What are two safety concerns are pointed out in the lab?

6. In this lab, your final mass of crucible and contents will be greater than your initial weight of crucible and magnesium. Explain why.