Name_____ Date_____

14 Determining an Empirical Formula

PRE-LAB DISCUSSION

In a sample of a compound, regardless of the size of the sample, the number of gram-atoms of one element in the sample divided by the number of gram-atoms of another element in the sample will form a small whole-number ratio. These small whole-number ratios can be used to determine the subscripts in the empirical formula of the compound. For example, suppose that in a 24-gram sample of a compound, there are 1.5 gram-atoms of carbon (18 g of carbon) and 6 gram-atoms of hydrogen (6 g of hydrogen). These numbers form the small whole-number ratio of 1 to 4:

$$\frac{\text{1.5 gram-atoms carbon}}{\text{6 gram-atoms hydrogen}} = \frac{1}{4}$$

The 1-to-4 ratio means that for every 1 atom of carbon in the compound, there are 4 atoms of hydrogen. The empirical formula of the compound is CH_4. (The compound's name is methane.)

In this experiment, the number of gram-atoms of each of two elements in a binary compound will be experimentally determined. From this information, the empirical formula of the compound will be determined.

This experiment will help you understand better the concepts of gram atomic masses and empirical formulas.

PURPOSE

Using mass relationships, show that magnesium and oxygen combine in a definite whole-number ratio by mass.

EQUIPMENT

crucible and cover
ring stand
iron ring
clay triangle
crucible tongs
dropper pipet
scissors
burner
balance
safety glasses

MATERIALS

magnesium ribbon (Mg), 35 cm

PROCEDURE

1. Clean a crucible and cover. Dry them by heating them in the hottest part of a burner flame for 3 minutes. Allow them to cool. Measure the mass of just the crucible and record this as (a) in your data table.
2. Cut a 35-cm length of magnesium ribbon into 1-cm pieces. Place the pieces in the crucible and measure the mass of the crucible and its contents (b).
3. Cover the crucible and place it in a clay triangle (Figure 14-1). Heat *gently* for 2 minutes. Using crucible tongs, carefully tilt the cover to provide an opening for air to enter the crucible. Heat the partially covered crucible *strongly* for 10 minutes.
4. Turn off the burner, cover the crucible, and allow the contents to cool. When the crucible is cool enough to touch, remove the cover and examine the contents. If any unreacted magnesium remains, replace the cover at a slight tilt and reheat the crucible strongly for several minutes.
5. Put the cover all the way on and allow to cool. After making sure that all the magnesium has reacted, use a dropper pipet to add enough water to the crucible to just cover the contents. Wash any material that may have spattered onto the inside of the cover into the crucible.

6. Holding the burner in your hand, *gently* heat the contents of the uncovered crucible by moving the burner slowly back and forth. Avoid spattering. Observe the odor of the vapor given off by wafting it toward your nose. Record your observation as (d).
7. When all the liquid has boiled off, repeat steps 5 and 6.
8. When all the liquid has boiled off a second time, *strongly* heat the uncovered crucible for 5 minutes.
9. Turn off the burner and allow the crucible and contents to cool. Measure the combined mass of the crucible + contents (c).

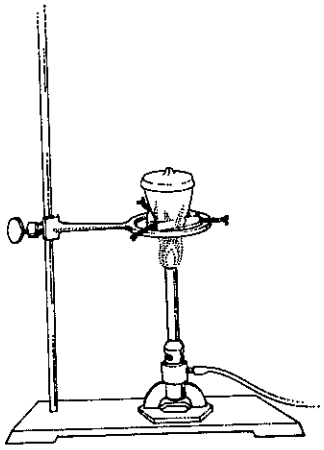

Figure 14-1