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Chemical Changes and Equations 19 5

There are many ways to detect or "observe" a chemical change — a change in composition. Some highly precise instruments enable us to measure not only the degree of change in composition, but also the change in energy which takes place when substances react chemically. For many reactions, the changes which occur in energy and composition during these reactions are similar. After observing many reactions, scientists begin to see a trend in properties and can develop generalizations about the nature of matter. Such generalization is the heart of chemistry.

To the beginning chemistry student, the first big problem is that of communication. When a chemical change does occur, what is a simple way of writing down this information so that it will form a record which can be understood by other chemists? Early chemists had the same problem. To make communication easier, the chemical elements, the building blocks of all matter, were assigned symbols so they could be referred to in a shorthand form. It was found that elements, in various ratios, interact to form new compounds which in turn react with other compounds to form still other compounds. A chemical equation represents a chemical reaction and indicates the substances which react and the new substances that are formed. For the equation to be completely correct it must be balanced. "Balanced" means that it has the correct coefficients. There must be the same number of each kind of atom (represented by a symbol) on both sides of the equation. For example, when iron rusts it combines with oxygen to form a new compound which is mostly Fe_2O_3. The chemical equation for this reaction would be:

$$4Fe + 3O_2 \rightarrow 2Fe_2O_3$$

Objective

In this experiment, you will work with three classes of chemical reactions — displacement, decomposition, and synthesis. You will attempt to identify some of the products and write balanced chemical equations for each reaction.

Equipment

- 2 large test tubes
- clay triangle
- small test tubes
- glass tubing
- crucible
- forceps
- flame spreader
- wooden splints
- evaporating dish

Procedure

A. Synthesis

1. Obtain a piece of magnesium about 13 cm long and roll it into a loose ball.
2. Place the Mg in a clean crucible and measure the mass of the crucible and its contents carefully to the nearest 0.01 g. Record the mass.
3. Place the crucible in a clay triangle, and place the clay triangle on a ring stand, as shown in Experiment 4, Figure 4-2, page 26.
4. Begin heating, slowly at first. Slowly increase the intensity of heat to the hottest flame of your laboratory burner. **CAUTION:** *The Mg may begin to burn. If it does burn, do not look directly into the flame.*

5. When the reaction is complete, stop heating. After the crucible has cooled slightly, remove it from the clay triangle with forceps. Measure the mass, then empty the crucible's contents into an evaporating dish.
6. Examine the contents for a change in composition. Add a few drops of water to the residue and try to detect the odor of ammonia (NH_3) gas. What does this suggest? (Hint: Is oxygen the only gas in air which will combine with Mg?
7. Compare the new mass with the original mass. If a reaction did occur, with what did the magnesium react?

B. Decomposition

1. From the stock glass tubing (provided by your teacher), use a triangular file to cut a piece of tubing about 15 cm long. Fire polish the ends and bend the glass tubing into a 90° angle. **CAUTION:** *Sharp glass and hot glass.* Your teacher may demonstrate the correct techniques for bending and fire polishing glass tubing. See the Laboratory Techniques in the front of this book.
2. Obtain two small spatulas full of $CuCO_3$ and place it in a large, dry test tube.
3. Insert the glass tube into a one-hole rubber stopper and insert the stopper in the test tube containing the $CuCO_3$. **CAUTION:** *Use a lubricant such as glycerol or water, and towels or some other hand protection. Work slowly. Do not force the tubing.*
4. Pour about 5 mL of lime water, $Ca(OH)_2(aq)$, into a small test tube. Place the end of the right angle glass tube in the limewater solution as shown in Figure 5-1.
5. Heat the tube containing the $CuCO_3$ while holding the end of the glass tube in the limewater solution. Continue heating until the bubbling has nearly stopped. A cloudy appearance in the $Ca(OH)_2$ indicates the presence of CO_2. Observe. Is there a change?
6. Let the test tube cool and empty the contents of both tubes.

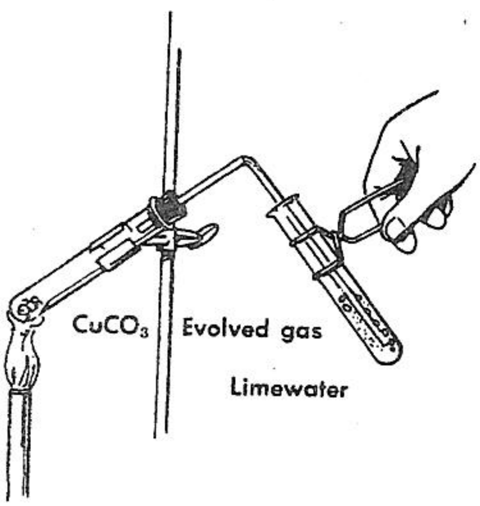

FIGURE 5-1. Testing for the presence of CO_2.

C. Displacement

1. Use the apparatus used for Part B. Place a small piece of zinc in a test tube and add 5 mL of 6*M* HCl. Insert the rubber stopper containing the glass delivery tube. **CAUTION:** *Keep away from open flame.*
2. A reaction should occur and a gas should escape from the tubing. With the glass tubing turned up, collect some of the gas being liberated. Collect the gas by displacement of air by inverting another test tube over the upturned gas delivery tube. See Figure 5-2.
3. Remove the test tube containing the gas from the glass tubing, keeping it inverted, and bring a burning splint near its mouth. A "pop" or "bark" indicates the presence of hydrogen gas.

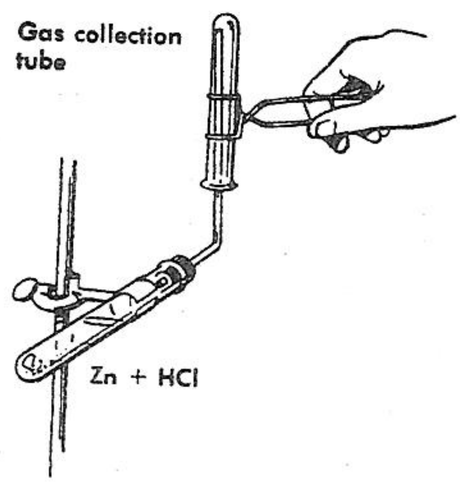

FIGURE 5-2. Collecting a gas by air displacement.

D. Optional Demonstration

1. Obtain about 2 g of zinc dust and about 1 g of sulfur. Mix thoroughly. **CAUTION:** *Be careful not to grind or crush the material as a violent reaction can occur.*
2. Under a fume hood place the mixture on an asbestos square and ignite with a laboratory burner. **CAUTION:** *The reaction will be very rapid with a large amount of smoke.*

Results and Conclusions

1. Write the word equation for each reaction.
2. Write a chemical equation for each of the reactions. Be careful to include the correct formulas for all of the reactants and products. Balance the equations.
3. Indicate the type of chemical change which has occurred in each reaction.

Questions and Problems

1. How can you tell if a chemical reaction has occurred? What are some distinctive changes that can be observed? How do these changes differ from physical changes?
2. When magnesium is burned in air what products are formed?
3. In Part C, the test for hydrogen was the sound resulting when some of the gas exploded. Do any other gases have this characteristic? If so, name one.
4. Which of the reactions in this experiment was exothermic, and which was endothermic?