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*Laboratory Investigation*

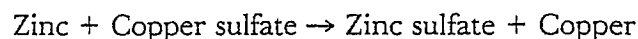
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## Single-Replacement Reactions

### Background Information

In nature, elements can occur either free, meaning uncombined with other elements, or chemically combined in a compound. The tendency of a particular element to combine with other substances is a measure of the activity of that element. The more active an element is, the more likely it is to combine. In a single-replacement reaction, an uncombined element replaces a less active element that is combined in a chemical compound. The less active element is then freed from the compound.

For example, in the reaction



zinc replaces the less active copper, combines with sulfate, and frees the copper from the compound.

In this investigation you will observe how various metals undergo single-replacement reactions when placed in acid. If the metal is more active than the hydrogen in the acid, it will replace the hydrogen and hydrogen gas will be released.



### Problem

How does a single replacement reaction occur?

### Materials (*per group*)

safety goggles  
5 test tubes  
test-tube rack  
1 M hydrochloric acid  
graduated cylinder  
zinc  
copper  
aluminum  
iron  
magnesium

## Procedure

1. Label each test tube with the name of one of the metals listed in the materials.
-  2. Put on your safety goggles. Carefully pour 5 mL of hydrochloric acid into each test tube.
-  3. One at a time, place the appropriate metal in each test tube. Observe what happens to the metal in each test tube and feel each test tube as the reaction proceeds. Record your data in Observations.
4. When you have completed the investigation, carefully pour off the acid, rinse the metal several times with water, and put it into a container provided by your teacher. Do not put any unused metal in the sink.

## Observations

1. Magnesium \_\_\_\_\_  
\_\_\_\_\_
2. Aluminum \_\_\_\_\_  
\_\_\_\_\_
3. Iron \_\_\_\_\_  
\_\_\_\_\_
4. Copper \_\_\_\_\_  
\_\_\_\_\_
5. Zinc \_\_\_\_\_  
\_\_\_\_\_

## Analysis and Conclusions

1. Write the single-replacement reaction that occurred between the acid and each metal.
  - a. Magnesium \_\_\_\_\_  
\_\_\_\_\_
  - b. Aluminum \_\_\_\_\_  
\_\_\_\_\_
  - c. Iron \_\_\_\_\_  
\_\_\_\_\_

d. Copper \_\_\_\_\_  
\_\_\_\_\_

e. Zinc \_\_\_\_\_  
\_\_\_\_\_

2. Were these reactions endothermic or exothermic? \_\_\_\_\_

Explain. \_\_\_\_\_  
\_\_\_\_\_

**Critical Thinking and Application**

1. Which of the metals are more active than hydrogen? \_\_\_\_\_  
\_\_\_\_\_

2. Which of the metals are less active than hydrogen? \_\_\_\_\_  
\_\_\_\_\_

3. What could you do to prove that hydrogen gas was produced as a result of these reactions? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. The rate at which hydrogen gas is produced as a result of these single-replacement reactions is an indication of the relative activity of the metals. List the metals in order of their activity from most active to least active \_\_\_\_\_  
\_\_\_\_\_

5. Nonmetals can also be involved in single-replacement reactions. If chlorine is more active than bromine, write the equation for the reaction between chlorine and potassium bromide. \_\_\_\_\_  
\_\_\_\_\_