Properties of Metals

EXPERIMENT 13A

Metals make up the majority of the elements in the periodic table. Some metals are highly reactive, such as those of Groups I and II. Other metals are relatively nonreactive, such as gold and silver.

There are some common properties of metals, such as electrical conductivity and the tendency to give up electrons in chemical reactions, forming positive ions. Other properties are distinctive for each individual metal. Some families of metals are very similar, such as the metals in the sodium family.

In this experiment, you will be working with several common metals. You will be comparing and contrasting some of the properties of these metals.

OBJECTIVES

1. to observe the appearance of several common metals, including magnesium, iron, aluminum, copper, and zinc
2. to determine the relative hardness of the metals
3. to determine the relative malleability of the metals
4. to determine the relative electrical conductivity of the metals
5. to determine the relative reactivity of the metals in water and acids

MATERIALS

Apparatus

small file
single-edge razor blade, knife, or nail
emery cloth or fine sandpaper
battery (6-V)
light bulb and socket
3 wires with alligator clips
10 test tubes (18- x 150-mm)
test tube rack
graduated cylinder (100-mL)
safety goggles
lab apron

Reagents

thin strips of the following metals: zinc, copper, magnesium, aluminum, and iron
small pieces of the same metals
1*M* hydrochloric acid
distilled water

PRELAB

Answer questions 1-5 on the Report Sheet.

PROCEDURE

Part I

1. Put on your laboratory apron and safety goggles.
2. Obtain a small strip of zinc, copper, magnesium, aluminum, and iron.
3. Record the appearance of the metals on the Report Sheet. Note the color, lustre, texture, etc.
4. Use a piece of emery cloth or sandpaper to shine the surface of each of the metals. Note any changes in the appearance of the metals as a result of sanding on the Report Sheet.
5. Use a knife, nail, or razor blade (as your teacher directs), and then a file, to determine the relative hardness of each of the metals. First, try to cut the metal with the knife, nail, or razor blade. Be very careful when "cutting"; be sure to wear your safety goggles. Then try to file the metals. Based on the ease of cutting and filing, list the metals in order of decreasing hardness on the Report Sheet.

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6. Malleability is the ability of a metal to be shaped. In order to determine the relative malleability, try to bend the strips of metal back and forth. The most malleable metals will bend back and forth very easily and will not break after repeated bending. Record the relative malleability of the metals on the Report Sheet.

Part II

1. Set up a battery, a light bulb and socket, and wires as shown in Figure 13A-1. Check to make sure that the bulb is working by connecting the light bulb directly to the battery, as shown in Figure 13A-2.
2. Test the electrical conductivity of each of the metals by connecting the strip of metal as shown in Figure 13A-3. Determine the relative conductivity of the metals by observing the brightness of the bulb. Record your results on the Report Sheet.

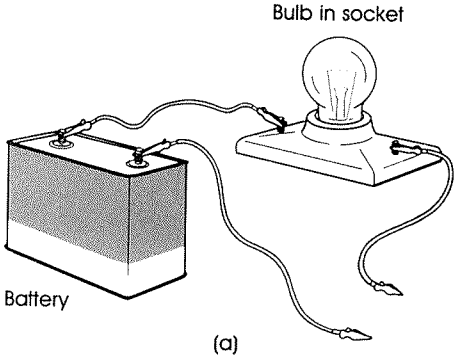

Figure 13A-1 *Setup for conductivity tests.*

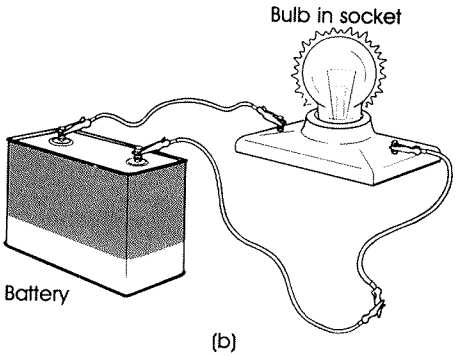

Figure 13A-2 *Check to show that the bulb works.*

Part III

CAUTION: Hydrochloric acid is corrosive to skin, eyes, and clothing. When handling 1M hydrochloric acid, wear safety goggles and lab apron. Wash spills and splashes off your skin and clothing immediately using plenty of water. Call your teacher.

1. Set up five test tubes in a test tube rack. Place 15 mL of distilled water in each of the tubes.
2. Place a small piece of one of the metals into each of the test tubes. Observe and record any immediate reaction. Wait ten minutes to observe any changes. Record these changes on the Report Sheet.
3. While you are waiting, set up another five test tubes and place 15 mL of 1*M* hydrochloric acid in each of the tubes. Place a small piece of each of the metals in the test tubes. Record any immediate reaction and any changes after ten minutes on the Report Sheet.
4. Observe as your teacher shows the reaction of the five metals in 3*M* nitric acid. This demonstration will be done in the fume hood. Record the results on the Report Sheet.
5. Clean up all of the materials. Before you leave the laboratory, wash your hands thoroughly with soap and water. Use a fingernail brush to clean under your fingernails.

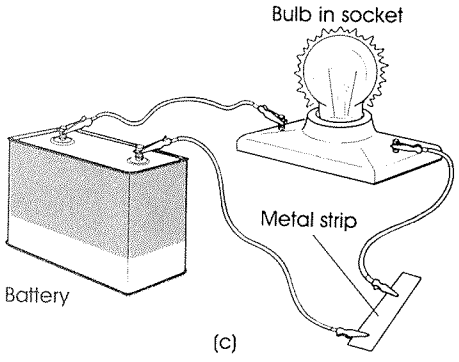

Figure 13A-3 *Conductivity test: If the bulb lights, the metal conducts electricity.*

POST LAB DISCUSSION

When metals react with acid, a gas is usually produced. For each metal that reacts with an acid, you will be asked to write a chemical equation. One example of the reaction of a metal with an acid is shown as follows:

$$Pb + 2\,HCl \rightarrow PbCl_2 + H_2$$

lead + hydrochloric acid → lead(II) chloride + hydrogen

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Properties of Metals

Name _____

Class _____ Date _____

EXPERIMENT 13A REPORT SHEET

PRELAB QUESTIONS

1. Define malleability. _____

_____

2. Think carefully about the many uses of metals in your everyday life. Write one use for each of the following metals:

iron _____

silver _____

copper _____

aluminum _____

magnesium _____

3. Based on what you know about metals, what are three properties that all metals have in common?

a. _____

b. _____

c. _____

4. What properties do all the members of Group I have in common? _____

_____

5. In this experiment, what is the test that will determine the hardness of the metals? _____

_____

OBSERVATIONS

Part I

1. Describe the appearance of each metal:

zinc _____

copper _____

magnesium _____

aluminum _____

iron _____

2. Describe how the appearance changes after using the sandpaper:

zinc _____

copper _____

magnesium _____

aluminum _____

iron _____

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3. Describe the results of the hardness test:

hardest _____

softest _____

4. Describe the results of the malleability tests:

most malleable _____

least malleable _____

Part II

Describe the results of the conductivity tests:

best conductor _____

worst conductor _____

Part III

	Zn	Cu	Mg	Al	Fe
Reaction with water immediately					
after ten minutes					
Reaction with 1*M* HCl immediately					
after ten minutes					
Teacher demonstration of reaction with 3*M* HNO_3					

CONCLUSIONS

1. Based on the results of this experiment, which metal would you choose to perform the indicated task? Explain your answer.

a. pipes for your house plumbing _____

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b. lightweight camping equipment _____

_____

c. structural support in a large building _____

_____

d. electrical wires _____

_____

2. For the reaction between each metal and hydrochloric acid, write a balanced chemical equation:

3. Which of the metals showed a reaction in water? _____

Write an equation for the reaction that occurred:

SYNTHESIS

1. Many of the metals commonly used in a variety of applications are alloys. What is the advantage of using an alloy of iron, rather than iron itself, for the manufacture of automobiles? _____

_____

2. Refer to your textbook to predict the results of this laboratory experiment with gold and silver:

	GOLD	SILVER
appearance		
hardness		
malleability		
reaction with water		

3. What are some common uses for magnesium alloys? _____

_____

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