47 REACTIVITY OF METALS
EXPERIMENT

Text Reference
Sections 24.1 and 24.3

PURPOSE

To measure the relative reactivities of selected metallic elements.

BACKGROUND

The application a metal is used for depends in part on its chemical reactivity. For example, gold, which is commonly used in jewelry, is highly resistant to chemical reactions. Sodium, however, is not used in jewelry because it is so reactive it will explode if it contacts water. The chemistry of the metals is based on their ability to lose electrons. Differences in chemical reactivity between metals depend on the relative ease with which they give up electrons.

You can measure the relative reactivity of two metals by placing a small pure sample of one metal in a solution containing the ions of the other metal. If the small metal sample is more reactive than the metal whose ions are in solution, electrons will move from the solid metal sample into the solution. For example, a piece of iron placed in a solution containing copper(II) ions will corrode, while fine copper particles deposit on the iron. However, no reaction occurs when a strip of copper metal is placed in a solution of iron(II) ions.

In this experiment, you will test the reactivities of a variety of metals with different metal ions. You will then use the results of your tests to construct a scale of relative reactivities of the metals.

MATERIALS (PER PAIR)

safety goggles
8 medium test tubes
1 test-tube rack
2 dropper pipets
glass-marking pencil
1 tweezers

solutions, 5% w/v, in dropper bottles:
- lead(II) nitrate, $Pb(NO_3)_2$ [T]
- copper(II) sulfate, $CuSO_4$ [T] [I]
- silver nitrate, $AgNO_3$ [T] [I]
- zinc chloride, $ZnCl_2$ [T]
- potassium chloride, KCl
- sodium chloride, NaCl
- magnesium chloride, $MgCl_2$

Thin metal strips, 0.25 mm thick, approximately 2.00 cm 0.50 cm:
- 8 strips copper, Cu
- 8 strips zinc, Zn
- 8 strips magnesium, Mg [F]
- steel wool

SAFETY FIRST!

In this lab, observe all precautions, especially the ones listed below. If you see a safety icon beside a step in the procedure, refer to the list below for its meaning.

Caution: Wear your safety goggles. (All steps.)

Caution: Magnesium metal is flammable. Keep this material away from open flames. (All steps.)

Caution: Solutions of lead and copper ions are toxic. (Steps 3–6.)

Caution: Silver nitrate is toxic and will leave dark brown stains on skin and clothing. (Steps 3–6.)

Note: Return or dispose of all materials according to the instructions of your teacher (Step 6.)

PROCEDURE

As you perform this experiment, record your observations in Data Table 1.

1. Polish metal strips of copper, zinc, and magnesium with steel wool until they are clean and shiny.

2. Using a glass-marking pencil, label eight test tubes with the numbers 1–8. Place the tubes in a test-tube rack.

3. To tube 1, add 5 drops of $Pb(NO_3)_2$ solution. To tube 2, add 5 drops of $AgNO_3$ solution. Using tweezers, add one strip of copper metal to each tube. Record your observations.
4. Add 5 drops of solution to each tube as follows: tube 3, $CuSO_4$; tube 4, $Pb(NO_3)_2$; tube 5, $MgCl_2$. Add a strip of zinc metal to each tube. Record your observations.
5. Add 5 drops of solution to each tube, as follows: tube 6, $ZnCl_2$; tube 7, NaCl; tube 8, KCl. Add a strip of polished magnesium metal to each tube. Record your observations.

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

Name _____ Class _____ Date _____

OBSERVATIONS

DATA TABLE 1: OBSERVATIONS OF METAL ACTIVITY			
Tube	Metal ion	Metal	Observations
1			
2			
3			
4			
5			
6			
7			
8			

ANALYSES AND CONCLUSIONS

1. Why is it necessary to polish the metal strips before doing the experiment?

_____

2. Write balanced chemical equations for those reactions that actually occurred.

_____

_____

_____

_____

3. Consult the activity series of metals in your textbook. Then complete the reactions that follow, indicating which would proceed without assistance (spontaneously) and which would require electrical energy.

$2Ag + Sn^{2+} \rightarrow$ _____

$Sn + 2Ag^{+} \rightarrow$ _____

$2Ag + Ni^{2+} \rightarrow$ _____

$Zn + Ni^{2+} \rightarrow$ _____

$Al + 3Ag^{+} \rightarrow$ _____

4. Using your experimental data, list the metals in order of increasing activity. Explain how you arrived at your list.

5. Using the results of problem 3, do you think there would be a reaction if strips of copper or zinc were placed in solutions of KCl or NaCl? Explain.

GOING FURTHER

Develop a Hypothesis

Based on the results of this lab, develop a hypothesis about how the relative activities of the metals correspond to their arrangement in the periodic table.

Design an Experiment

Propose an experiment to test your hypothesis. If resources are available and you have your teacher's permission, perform the experiment.