The Hollow Penny

Introduction

Pennies are made of copper, aren't they? The outside is certainly made of copper, but that's not the whole story. Before 1982, pennies contained about 95% copper and 5% zinc. After 1982, however, the composition of pennies was changed to contain mostly zinc and only a small amount of copper. In this activity, the percentage of copper and zinc in post-1982 pennies will be determined.

Concepts

- Activity Series of Metals
- Redox reactions

Materials

Hydrochloric acid solution, 6 M, HCl, 40 mL
Water, 125 mL
Balance
Beaker, 150-mL
Beaker, 250-mL
Graduated cylinder, 25-mL
Paper towels
Post-1982 penny
Pre-1982 penny
Tongs
Triangular file

Safety Precautions

Hydrochloric acid solution is corrosive to skin and eyes and is moderately toxic by ingestion and inhalation. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. This activity requires the use of hazardous components and/or has the potential for hazardous reactions. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Using a triangular file, file three notches in a pre-1982 and a post-1982 penny. See Figure 1.
2. Weigh both pennies on a balance. Records these masses.
3. Pour about 40 mL of 6 M hydrochloric acid solution into a 150-mL beaker. Using tongs, place the pennies in the beaker of hydrochloric acid solution so that they are both completely submerged. Observe the reaction between the hydrochloric acid solution and the pennies.
4. Set the beaker in a safe place and allow the reaction to continue overnight.
5. Using tongs, transfer both pennies from the hydrochloric acid solution to a 250-mL beaker of water. Still using the tongs, move the pennies through the water to rinse them. Remove each penny from the water and hold each under running water to thoroughly rinse.
6. Observe the center of each penny through one of the notches.
7. Dry each penny with a paper towel. Allow them to dry completely overnight.
8. Weigh each completely dry penny on a balance. Record the masses of both pennies.
9. Compare the masses of the pennies before and after submerging them in the hydrochloric acid solution. Compare the inside of each penny before and after submerging them in the hydrochloric acid solution. What is the effect on each penny?

Figure 1.

Publication No. 10238
061616

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Neutralize and dispose of the hydrochloric acid solution according to Flinn Suggested Disposal Method #24b.

Tips

- The reaction between the post-1982 penny and the hydrochloric acid solution is rapid. Fizzing due to the generation of hydrogen gas can be violent enough to spatter drops of hydrochloric acid solution out of the beaker. If 150-mL beakers are not available, use larger beakers, not smaller ones, to avoid spattering.
- For a variation on this activity, have students file away the entire copper-ridged edge of the pennies, not just three notches. With this band of copper removed, once the hydrochloric acid solution reacts with the zinc, only the outer foils of copper will remain on the post-1982 penny. Instead of making hollow pennies, copper foils with penny imprints are the result.
- This activity works well as an open-ended, inquiry-based activity. Do not tell students before the lab what to expect. Instead, let them determine the difference between the pennies, then hypothesize as to what other metal might be inside the post-1982 penny. This is an excellent way to teach the activity series of the metals.

Discussion

Before 1982, pennies contained about 2.95 g copper and 0.15 g zinc. During 1982, however, the manufacturing of pennies changed. There were seven different mintings of pennies in 1982. After 1982, the composition of pennies was changed to contain about 2.46 g of zinc and only 0.06 g of copper. The change in composition was for economic reasons. As of June 1999, copper sold for about $0.60 per pound, while zinc sold for about $0.45 per pound—a savings of about 25%. Current prices of copper and zinc are found in the financial pages of most newspapers and on the Internet. Have students find the current prices of copper and zinc and calculate and compare the values of a pre-1982 penny and a post-1982 penny. The U.S. Mint has a nice Web page (www.usmint.gov) with information about how coins are made and specifications for each coin. Interestingly, during World War II, pennies were composed of 100% zinc because copper was needed to make brass shell casings.

In the activity series of metals, zinc appears above hydrogen while copper is below hydrogen. Therefore, copper cannot replace hydrogen ions while zinc can. This is why the copper does not react with the hydrochloric acid but the zinc does. The standard reduction potentials for each species can also be used to explain the results. When zinc metal is combined with an acid, the net cell potential is positive ($E° = +0.76$ V). The net cell potential is negative for the reaction between copper metal and an acid. ($E° = -0.34$ V) Spontaneous reactions have positive net cell potentials, so the reaction between zinc and an acid will be spontaneous, while the reaction between copper and an acid will not.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard F: Science in Personal and Social Perspectives, science and technology in society
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard F: Science in Personal and Social Perspectives, science and technology in local, national, and global challenges

Reference

ChemCom, Teacher's Guide, 3rd ed.; Stanitski, C. L., ed.; Kendall/Hunt: Dubuque, IA, 1998; pp 48, 173.

Materials for *The Hollow Penny* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP5609	Hollow Penny—Student Laboratory Kit
H0033	Hydrochloric Acid, 6 M, 500 mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.