The Floating Penny

Introduction

Pennies minted before 1982 were made entirely of copper. Pennies minted after 1982 have a core of zinc that is plated with a very thin layer of copper. This experiment demonstrates the different reactivities of zinc and copper with an acid.

Concepts

- Reactions of metals and acids
- Redox reactions
- Reduction potentials
- Activity series

Materials

Hydrochloric acid solution, 6 M, HCl, 20 mL
Beaker, 100-mL
Beaker of water
File, triangular
Forceps or tongs
Graduated cylinder, 50-mL
One post-1982 penny
One pre-1982 penny

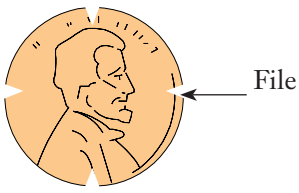
Safety Precautions

Hydrochloric acid is corrosive to eyes, skin, and other tissue and is highly toxic by ingestion or inhalation. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. In addition, hydrochloric acid vapors are corrosive and very irritating to mucous membranes. Reactions should be carried out under an operating fume hood or in a well-ventilated area. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

If 6 M hydrochloric acid solution is not available, prepare this solution by diluting one volume of concentrated (12 M) hydrochloric acid with an equal volume of distilled water. *Remember:* Always add acid to water. This dilution should be done in a fume hood or well-ventilated area because of the presence of hydrochloric acid fumes.

Procedure



1. Obtain both a pre-1982 and a post-1982 penny. Use a file to make four 1-mm indentations 90° apart into each penny. Make sure the indentations on the post-1982 penny extend through the outer copper layer into the shiny zinc core.
2. Place both pennies into a 100-mL beaker. Place the beaker in an operating fume hood.
3. Add 20 mL of 6 M hydrochloric acid solution to the beaker. Observe.
4. Leave the reaction undisturbed overnight in the fume hood. The next day, the post-1982 penny should be floating, while the pre-1982 penny appears unchanged. Observe any bubbles on either penny.
5. Carefully remove the pennies using forceps or tongs and place the pennies in a beaker of water to rinse off any excess acid. Be careful not to crush the hollow post-1982 penny. Make sure the inside of the penny is well rinsed to remove all the acid.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Excess acid solution should be neutralized, then flushed down the drain with excess water according to Flinn Suggested Disposal Method #24b. Students can be allowed to keep their pennies, provided that they have washed them very thoroughly with water.

Connecting to the National Standards

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

Unifying Concepts and Processes: Grades K–12
Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Discussion

Hydrochloric acid reacts readily with the zinc core of the newer pennies, according to the reaction:

$$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

Zn^{2+} has a lower reduction potential than H^+; therefore, zinc is more "active" than hydrogen in the activity series. This means that the zinc core of the penny will reduce the H^+ ions from the acid solution to hydrogen gas, H_2. The zinc metal is oxidized to Zn^{2+} ion and dissolves in solution. Copper, on the other hand, is less "active" than hydrogen in the activity series (Cu^{2+} has a higher reduction potential than H^+). Copper metal, therefore, will not reduce the H^+ ions in solution and the copper metal does not dissolve.

The average post-1982 penny contains approximately 2.5 g of zinc. This amount of zinc requires almost 13 mL of 6 M hydrochloric acid to fully react. Therefore, it is important that approximately 20 mL of 6 M hydrochloric acid solution be used to ensure the reaction of all of the zinc.

Reference

Borgford, C. L., and Summerlin, L. R. *Chemical Activities;* American Chemical Society: Washington, DC, 1988; pp 77–78.

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

Catalog No.	Description
H0033	Hydrochloric acid solution, 6 M, 500 mL
GP1010	Beaker, borosilicate glass, low form, graduated, student grade, 100 mL
AP8401	File, triangular, 6½9
AP8266	Tongs, crucible

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