

# Turning Copper Pennies into “Silver” and “Gold”!



## Introduction

Get rich quick by turning an ordinary penny into “silver” and then “gold”! Simple and eye-catching chemical reactions demonstrate essential concepts.

## Concepts

- Oxidation–reduction
- Alloys

## Materials

Copper pennies, very clean and shiny, 2	Balance, 0.1-g precision
Sodium chloride, NaCl, 2.5–3 g	Beakers, 100-mL, 2
Vinegar, 15 mL	Graduated cylinder, 50-mL
Zinc, granular, Zn, 1 g	Hot plate
Zinc chloride solution, ZnCl <sub>2</sub> , 1 M, 25 mL	Tongs
Water, distilled or deionized	Towel or paper towel

## Safety Precautions

*Zinc chloride solution and granular zinc are severe skin irritants. Zinc metal dust is very flammable; there may be zinc dust present at the bottom of the granular zinc container. Do not use zinc dust in this procedure. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Safety Data Sheets for additional safety, handling and disposal information.*

## Preparation

1. Weigh out and place 2.5–3.0 g of sodium chloride and 15 mL of vinegar in a clean, 100-mL beaker.
2. Clean two pennies by placing them in the sodium chloride/vinegar solution until they are shiny.
3. Remove the pennies using tongs and rinse thoroughly with water. Dry completely with a towel. *Note:* Do not handle the clean pennies with your hands. The oils from your skin may interfere with the zinc-plating reaction.

## Procedure

1. In a clean 100-mL beaker, mix together 1.0 g of granular zinc and 20 mL of 1 M zinc chloride solution. *Note:* Chemical splash goggles must be worn.
2. Place the beaker with the ZnCl<sub>2</sub> and zinc on a hot plate set to a medium heat setting.
3. Carefully and gently heat the mixture until the solution boils.
4. Using tongs, immerse two pennies in the mixture until they appear “silver.”
5. Use tongs to remove the pennies. *Caution:* The pennies will be very hot. Carefully dip the pennies into a beaker of distilled water. Shine the pennies with a towel. Set one treated penny aside to be used for comparisons.
6. Using tongs, place the other treated penny on the hot plate until the penny turns to a golden color. Using a heat resistant glove or tongs, flip the penny every 30 seconds to avoid burning.
7. Use tongs to remove the penny from the hot plate and immediately dip the penny into a fresh beaker of distilled water. The penny will be extremely hot and should be handled with tongs until it has cooled for several minutes. Students will enjoy showing their friends their “silver” and “gold” pennies.

### Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The zinc chloride solution may be poured off of the granular zinc and be disposed of according to Flinn Suggested Disposal Method #26b. The granular zinc may either be reused or discarded in the solid waste according to Flinn Suggested Disposal Method #26a.

### 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 Standards: Grades 9–12***

Content Standard B: Physical Science, structure and properties of matter, chemical reactions

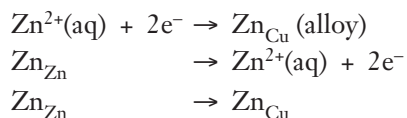
### Tips

- Clean pennies are necessary in this lab because a smooth surface is needed for the “silver” and “gold” to plate. Pennies can be cleaned with the salt/vinegar solution as described in the preparation section. Alternatively, they can be cleaned by soaking them in dilute hydrochloric acid solution. The pennies can be scrubbed with steel wool before starting the demonstration if necessary.
- Students will likely not believe that “silver” and “gold” were made in the lab. Have them determine the actual product.
- Pre-1982 pennies are 95% copper and 5% zinc; post-1982 pennies are 97.6% zinc, coated with a thin electroplating of copper. Either pre- or post-1982 pennies can be used for this lab as long as they are very clean and shiny.
- There is a widely circulating procedure to turn pennies into gold which uses zinc dust and sodium hydroxide. The concern with this procedure is it evolves flammable hydrogen gas which often ignites upon disposal. The method described in this activity is safer to perform and eliminates the fire hazard.
- Flinn Scientific offers this activity as a kit. It is called *The Gold Rush—Turning Pennies into Silver and Gold*, Catalog No. AP8895.

### Discussion

In this reaction, a penny is placed in a boiling solution of 1 M zinc chloride containing granular zinc. The penny develops a zinc “silver-colored” coating. When removed from the solution and placed on the surface of the hot plate, the brass alloy coating on the penny turns a golden color.

Placing copper, or a copper-coated penny, in a mixture of zinc metal and aqueous zinc chloride causes zinc metal to plate out on the copper surface. This reaction occurs due to electrochemical potential differences that result when different “forms” of zinc solid are contained in a solution of 1 M  $\text{ZnCl}_2$ . The driving force in this reaction is formation of a brass alloy on the surface of the copper.



*Note:*  $\text{Zn}_{\text{Zn}}$  = zinc that deposits on the granular zinc  
 $\text{Zn}_{\text{Cu}}$  = zinc that deposits on the copper  
 $E = +1.0 \text{ V}$

## Turning Copper Pennies into "Silver" and "Gold"! *continued*

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Brass is a copper-zinc alloy. An alloy is a mixture of two or more metals dissolved in each other when molten (or a metal and non-metal fused together). The percentages of copper and zinc in brass vary depending on the type of brass. These differences allow the penny in this activity to turn several different colors. When a copper penny is added to the zinc solution, the zinc ions migrate to the copper where they are reduced to metallic zinc and deposited. The silver coating on the penny is the gamma-form of the brass alloy with zinc content greater than 45%. This gives the penny its silver coloring. When the zinc-coated penny is heated, the penny becomes gold in color. The gold color is due to the zinc migrating through the copper to convert to the alpha-form of brass alloy which has a zinc content of less than 35%. This form of the brass alloy is a golden color.

### References

Szczepankiewicz, Steven H. *Journal of Chemical Education*; **1995**, 72, pp 386–388.

**Materials for *Turning Copper Pennies into “Silver” and “Gold”!* are available from Flinn Scientific, Inc.**

Catalog No.	Description
Z0028	Zinc, Granular, 100 g
Z0040	Zinc Chloride Solution, 1 M, 500 mL
S0063	Sodium Chloride, 500 g
V0005	Vinegar, 4 L

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