

The Alchemist's Dream

Turning Pennies into "Silver" and "Gold" with Redox Chemistry

Purpose

Use Redox chemistry to turn an ordinary copper penny into "silver" and then into "gold"

Background Knowledge

1. What is an oxidation – reduction reaction?
2. In this activity, you will create a metal alloy. What is an alloy?
3. Research the term "alchemy" on the Internet. How is this activity related to the practice of alchemy?

Materials

- Copper pennies, very clean and shiny, 2
- Sodium Hydroxide solution, 6 M, 10 mL
- Zinc, granular, Zn, 5 g
- Graduated cylinder, 25-mL
- Bunsen Burner
- Tongs
- Paper towel
- Balance
- Hot mitt
- Ring Stand
- Ring Clamp
- Wire Gauze
- Steel wool
- Evaporating dish
- Water, tap

Procedure

Safety Precautions

- Sodium hydroxide and granular zinc are severe skin irritants.
- Boiling sodium hydroxide solution can produce noxious fumes, be careful NOT to boil the solution.
- Wear chemical splash goggles.
- Wash hands thoroughly with soap and water before leaving the laboratory.

Protocol

1. Prepare two pennies by scrubbing them with steel wool until they are clean and shiny. Polish the pennies on top of a paper towel so the steel wool does not scratch the lab table. *Note:* Do not handle the clean pennies with your hands. The oils from your skin may interfere with the zinc-plating reaction.
2. In a clean evaporating dish, mix together 5.0 g of granular zinc and 10 mL of 6 M sodium hydroxide.
3. Place the evaporating dish with the NaOH and zinc on a wire gauze and ring stand setup over the Bunsen burner at a medium heat setting.
4. Carefully and gently heat the mixture until the solution is hot, approximately 2 minutes. *Note:* Be careful not to boil and spatter the solution. If the solution begins to boil, remove the burner and let the dish cool.
5. Using tongs, immerse two pennies in the mixture until they appear "silver" (approximately 3–4 minutes)
6. Use tongs to remove the pennies. *Caution:* The pennies will be very hot. Carefully wash the pennies under running tap water in the sink until they are cool.
7. Dry the pennies with a towel (do not rub). Set one treated penny aside to be used for later comparisons.

8. Using tongs, hold the other treated penny over the Bunsen burner until it turns to a golden color. *Note: The production of gold color should take no more than 3-5 seconds. Any longer, and the penny may melt.*
9. Remove the penny from the flame and wash it with tap water. The penny will be extremely hot and should be handled with tongs until it has cooled for several minutes.
10. Blot the penny dry with a paper towel (do not rub).
11. Clean up your lab station. Enjoy showing off your "silver" and "gold" pennies to your friends and family!

Data Table

	Penny 1	Penny 2
Year of the Penny		
What color did the penny turn when heated with granular zinc and sodium hydroxide solution?		
What is the color of the second penny upon heating it?		

Discussion

In this reaction, a penny is placed in a boiling solution of 6 M sodium hydroxide containing granular zinc. Placing copper, or a copper-coated penny, in a mixture of zinc metal and aqueous sodium hydroxide causes zinc metal to plate out on the copper surface. The penny develops a zinc "silver-colored" coating. When removed from the solution and heated in a Bunsen burner, the brass alloy coating on the penny turns a golden color.

Brass is a copper-zinc alloy. An alloy is a mixture of two or more metals dissolved in each other. 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.

Analysis

1. Research the composition of pennies. What was the composition of each of your pennies prior to treatment?
2. Why is it necessary that the pennies be thoroughly cleaned before beginning this activity?
3. After the pennies were dipped in the granular zinc/sodium hydroxide solution they had a silver-colored coating. This was not actually due to the presence of silver, what was the silver coating?
4. Unfortunately, the copper pennies were not turned to real gold. What is responsible for the golden coating?