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The Gold Rush

Turning Pennies into Silver and Gold

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Introduction:

Have you ever turned an ordinary copper penny into "silver" and then into "gold"? Get rich quick by demonstrating this short and simple procedure!

Chemical Concepts:

- Oxidation–reduction
- Alloys

Materials (for each demonstration):

Copper pennies, dated 1982 or earlier
Sodium chloride, NaCl, 25 g*
Sodium hydroxide solution, NaOH, 3 M, 175 mL*
Vinegar, 110 mL*
Zinc, granular, Zn, 10 g*
Balance
Beakers, 100-mL, 2
Bunsen burner or hot plate
Graduated cylinder, 50-mL
Ring stand setup
Tongs
Water, distilled or deionized

**Materials included in kit.*

Caution:

This activity requires the use of hazardous components and/or has the potential for hazardous reactions. Please review the Safety Precautions section and relevant Material Safety Data Sheets before beginning this activity.

Preparation:

1. Mix together 2.5–3 grams of sodium chloride and 15 mL of vinegar in a clean, 100-mL beaker.
2. Clean the copper pennies by placing them in the sodium chloride/vinegar solution until they are shiny.
3. Remove the pennies using tongs and rinse them thoroughly with water. Dry them with a towel. Do not handle the clean pennies with your hands. The oils from your skin can interfere with the reaction.

Procedure:

4. Mix together 1.0 gram of granular zinc and 25 mL of 3 M sodium hydroxide solution in a clean 100-mL beaker. (*Note:* Chemical splash goggles must be worn.)
5. Assemble a ring stand with a ring clamp and wire gauze as illustrated in Figure 1. Place the beaker with the NaOH and zinc on the wire gauze and surround the beaker with a second ring clamp to help with stability.
6. Carefully and gently heat the mixture with a Bunsen burner (or hot plate) until the solution just begins to bubble and steam. (*Caution:* Do not allow the solution to boil or splatter.)
7. Using tongs, immerse two pennies in the mixture until they are completely coated with "silver."
8. Use tongs to remove the pennies. (*Caution:* The pennies will be very hot.) Carefully dip the pennies into a beaker of distilled water. Shine with a towel. The pennies should now appear silver. Set one treated penny aside to be used for later comparisons.
9. Using tongs, heat the other treated penny in a burner flame until the penny turns to "gold."
10. 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.

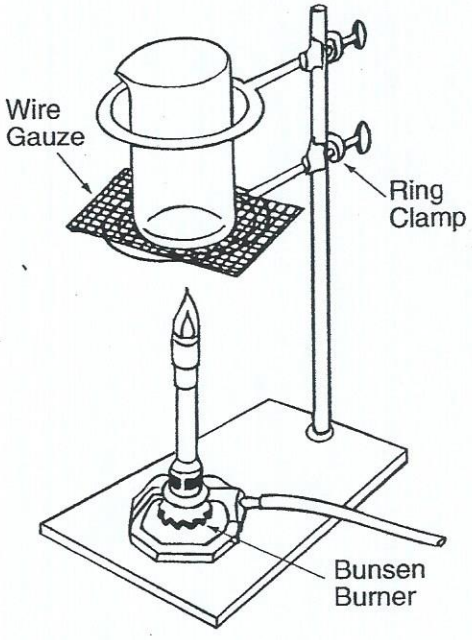

Figure 1. Ring stand setup for the reaction between zinc and sodium hydroxide

Tips:

- Enough materials are provided to perform this demonstration seven times: 10 grams of zinc, 175 mL of 3 M sodium hydroxide solution, 25 g of sodium chloride, and 110 mL of vinegar. Pennies are needed but not provided in the kit.
- Clean pennies are necessary in this lab as the surface is smoother for the plating of the "silver" and "gold." Pennies can be cleaned with the salt/vinegar solution as described in the preparation section. Or they can be cleaned by soaking them in dilute hydrochloric acid solution. The pennies can then be scrubbed with steel wool before starting, if necessary.
- Students will likely not believe that "silver" and "gold" was made in this lab. Have them determine what was made.
- 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; however, pre-1982 pennies have been shown to work better, as long as they are cleaned well and have a shiny, smooth surface. Since post-1982 pennies contain mostly zinc, they tend to warp if overheated (melting point of copper = 1083 °C; melting point of zinc = 420 °C). Also, since there is such a small amount of copper, the brass "gold" alloy formed is not as apparent.

Discussion:

In this reaction, sodium zincate (Na_2ZnO_2) is formed by heating elemental zinc with sodium hydroxide solution.

$$Zn(s) + 2NaOH(aq) \longrightarrow Na_2ZnO_2(aq) + H_2(g)$$

When a copper penny is added to the solution, the zincate ions (ZnO_2^{2-}) migrate to the copper where they are decomposed and reduced to metallic zinc. The silver color produced is due to the metallic zinc coating the penny.

When the zinc-coated penny is heated, the penny becomes gold in color. The gold color is due to the zinc and copper combining to form brass.

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 a non-metal fused together). The percentages of copper and zinc in brass vary depending on the type of brass, and there are many kinds of brass. Low zinc brasses contain less than 20% zinc and are easy to bend. Yellow brasses contain 34–37% zinc. Some brasses contain small percentages of other elements like aluminum, tin, and silicon.

Safety Precautions:

Sodium hydroxide solution is extremely corrosive and can cause skin burns and severe eye damage. Care should be taken when heating it so that it doesn't splatter. Zinc metal dust can be very flammable; dust may be present at the bottom of your bottle of granular zinc. Do not use zinc dust. Students should immediately clean up any spills and wash their hands when finished. Due to the hazards involved in heating the 3 M sodium hydroxide solution, elementary and middle school students should not perform this experiment; it should be performed as a teacher demonstration. High school students must be familiar with safety rules and aware of the hazards involved before performing this lab. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

Disposal:

The residual zinc from this experiment is a fire risk. The sodium hydroxide on the zinc must be removed. The best way to remove the sodium hydroxide from the zinc is to rinse the zinc with copious quantities of water. To do this, have students pour the residual zinc/sodium hydroxide into in a 1-L or 2-L beaker. Place the beaker in a large sink and slowly run water into the beaker. Allow the water to run for at least 20 minutes. Drain the water from the beaker and dry off the zinc. The zinc can either be reused or discarded in the solid waste according to Flinn Suggested Disposal Method #26a. Please consult your current *Flinn Chemical & Biological Catalog/Reference Manual*. Do not discard the zinc if you have not followed the above process. Any leftover sodium hydroxide solution can be diluted and rinsed down the drain.

Acknowledgment:

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Chemicals for the *Gold Rush* penny lab are available from Flinn Scientific, Inc.:

Catalog No.	Description	Price/Each
AP8895	The Gold Rush—Chemical Demonstration Kit	Consult Your Current *Flinn Catalog/Reference Manual.*
Z0028	Zinc, granular, 100 g	
S0242	Sodium hydroxide solution, 6 M, 500 mL	
S0063	Sodium chloride, 500 g	
V0005	Vinegar, 4 L	