



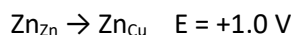
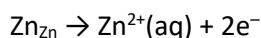
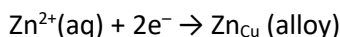
## Experiment #1 – Penny Lab

### Introduction

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

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.



Notes:  $\text{Zn}_{\text{Zn}}$  = zinc that deposits on the granular zinc,  $\text{Zn}_{\text{Cu}}$  = zinc that deposits on the copper

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.

### 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.



## Notes

- 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.

## Procedure

- 1) In a clean 100-mL beaker, mix together 1.0 g of granular zinc and 20 mL of 1 M zinc chloride ( $\text{ZnCl}_2$ ) solution. Note: Chemical splash goggles must be worn.
- 2) Place the beaker with the  $\text{ZnCl}_2$  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.