Turning Copper into Silver into Gold

Student Worksheet

Name_____

Overview: Get out your magic wands and prepare to be amazed at yourself as you use chemistry to turn plain old pennies into silver, then into gold!

What to Learn: You should understand that when you galvanized your penny you put a coating of silver zinc on it. When you heated this copper penny with the zinc coating, a brass alloy formed.

Materials

- propane torch with adult help (or flame from gas stove)
- shiny copper pennies
- distilled white vinegar
- Pyrex glass beaker
- sodium hydroxide, NaOH (solid) (MSDS)
- zinc powder/dust, Zn (MSDS)
- alcohol burner
- tripod stand
- lighter with adult help
- wire mesh screen
- popsicle sticks
- distilled water
- salt
- disposable cup (or jar)
- gloves
- goggles
- tweezers or pliers

Lab Time

1. Clean any dirty-looking pennies
    a. Put some salt in a small jar. Add enough distilled white vinegar to dissolve the salt.
    b. Drop in pennies. It is best if they do not touch each other, so that the entire surface of the penny is free to contact the salt solution.
    c. Let sit for a few minutes while you prepare the next step.
2. Make silver!
    a. Carefully uncap zinc dust, Zn. Using a clean popsicle stick, scoop an end-full of dust and place it into a small beaker. Cap chemical and put aside.
    b. Use a new popsicle stick to put approximately the same amount of sodium hydroxide, NaOH, into the beaker. If using pellets, simply pour in a few.
    c. Add a small amount of distilled water (approximately ¼ cup).
    d. Put a wire mesh screen on a tripod stand, and place the stand over an alcohol burner. Place the beaker on the screen.

e. With adult help, light the alcohol burner. Stir with a stirring rod or popsicle stick. Note: If you take out your stirring apparatus, carefully place it on a folded-up paper towel. This contains sodium hydroxide, a very strong base. You do not want this on your furniture!
f. While this is heating, check out your pennies. If they are shiny, remove, rinse with water, and wipe dry with a paper towel.
g. Continue to heat the sodium hydroxide solution until it is close to boiling, but do not let it boil! At this point, remove the alcohol burner and cap to extinguish.
h. Carefully drop in a few pennies. Don't let them touch one another because the copper surface needs to be as exposed as possible. Leave in 5-10 minutes.
i. Use tongs to reach in and retrieve the silver pennies. Remember not to touch them. They are covered with sodium hydroxide!
j. Rinse under a lot of water and wipe dry.

3. Make gold!
    a. With adult help, put the penny into the flame from a propane torch or gas burner. Wait for a few seconds until the gold color appears, then pull it out. If you wait too long, the brass coating will burn off.
    b. Put under cold water until it cools, then it may be touched.

DISPOSAL INSTRUCTIONS: If you simply wipe out the beaker with a paper towel and toss it in the trash, you run the risk of igniting your trash can because the combination of sodium hydroxide and zinc is very exothermic (lots of heat is generated).

Make sure to use plenty of water to remove the sodium hydroxide first before removing the metal. Sodium hydroxide will not harm the plumbing in the sink as it is also used as a drain cleaner (dissolves hair, etc.) but don't get it on your hands! Vinegar will neutralize any residual sodium hydroxide.

Turning Copper into Silver into Gold Data Table

Make a diagram of each part of this experiment. Label all chemicals.

Cleaning the Penny	Turning Silver (Galvanization)	Turning Gold (Forming brass)

Exercises Answer the questions below:

1. One student decided to use soap and water to clean his pennies. No matter how hard he scrubbed, the dark color wouldn't budge. Why didn't his idea work?

2. What happened to your penny when you galvanized it?

3. What would happen if you dropped a whole handful of clean pennies into the hot zinc and sodium hydroxide solution? Would they all come out silver?

4. What did the heat from the torch have to do with the experiment? What formed on the penny as a result?

Exercises

1. One student decided to use soap and water to clean his pennies. No matter how hard he scrubbed, the dark color wouldn't budge. Why didn't his idea work? (The pennies weren't dirty, but had a coating of copper oxide on them. A solution of vinegar and salt will react together to remove the oxide, but soap won't do the trick.)
2. What happened to your penny when you galvanized it? (A coating of zinc formed over the penny.)
3. What would happen if you dropped a whole handful of clean pennies into the hot zinc and sodium hydroxide solution? Would they all come out silver? (The reaction wouldn't work as well, because when the pennies piled up on top of each other some of their surfaces wouldn't have good contact with the solution.)
4. What did the heat from the torch have to do with the experiment? What formed on the penny as a result? (The heat fused the copper and zinc together, forming a brass alloy.)

Closure: Before moving on, ask your students if they have any recommendations or unanswered questions that they can work out on their own. Brainstorming extension ideas is a great way to add more science studies to your class time.