

Make Copper Pennies Appear Silver and Gold

Objective: Use two different types of electrochemical cells – galvanic and electrolytic – to plate a copper penny with zinc. This process is called electroplating.

Definitions

Cation: A positively charged ion

Oxidation: Loss of electrons

Reduction: Gain of electrons

Electrode: An electrical conductor that makes contact with the metallic part of a circuit.

Electrochemical Cell: A device that derives electrical energy from a chemical reaction (*galvanic*) or uses electrical energy to drive a chemical reaction (*electrolytic*)

Galvanic Cell: Spontaneous chemical reactions take place at electrodes, converting chemical energy into electrical energy

Electrolytic cell: Electricity is used to drive a chemical reaction that does not occur spontaneously

Electroplating: Uses electrical current to reduce dissolved metal *cations* so that they form a metal coating on an *electrode*.

Materials:

- 2 Clean Pennies (You can clean pennies in a warm water bath with soap. Use a brush to remove major deposits. Then rinse with vinegar)
- 250 mL Beaker
- 20g Zinc Sulfate (If you don't have zinc sulfate or can't make it, you can also use zinc chloride. This can be made by simply mixing hydrochloric acid with zinc metal and waiting until the fizzing stops.)
- 3 Pieces Solid Zinc Metal
- Hot Plate
- Metal Tongs
- 100 mL beaker filled with water
- Safety Glasses and gloves
- Metal Tweezers
- Stop Watch

Procedure:

1. Weigh each penny (using weigh boat) and record the weight on the next page. Remember to keep track of which penny is what weight.
2. **EXPERIMENT 1**- Place 250 mL beaker on a hot plate
3. Add two pieces of solid zinc metal (lay horizontally across the bottom of the beaker)
4. Put 20 grams of Zinc Sulfate in the beaker
5. Pour 80 mL of water into the beaker
6. Turn hot plate on and bring water to a boil
7. Once boiling, use your tweezers to place penny 1 directly on top of the zinc metal (the penny and zinc metal must be touching for the reaction to take place)

8. Cover the 250 mL beaker with the glass cover
9. Wait about 15 minutes for the reaction to take place
10. Once you have observed that the penny changed color you may take it out with the metal tongs, rinse with water, dry it and then place it in the weigh boat
 - a. Weigh and record penny 1's weight
 - b. Describe the appearance of the penny.

11. Before the next step, describe what you think will happen by placing your zinc-plated penny on a hot plate.

12. Using your tongs now place the penny directly on the hot plate and observe what happens
13. Once you observe a change use your tongs to remove the penny from the hot plate and weight and record its weight. (Be careful the penny will be HOT)
 - a. Describe what happened when you place the zinc-plated penny on the hot plate. Why do you think that this happened?

14. Turn off your hot plate.
15. **EXPERIMENT 2**- For the next portion of the experiment, you will use the same solution that was prepared for the first part.
16. Connect one end of the red wire to the long zinc bar and the other end to the positive (+) terminal of the battery
17. Connect one end of the black wire to penny 2 and one end to the negative (-) terminal of the battery
 - Once you have hooked them up, do not touch the ends together; keep your fingers on the plastic/rubber and not the metal
18. Place the long zinc bar in the solution
19. Place penny 2 in the solution while observing it very closely. Be careful to only submerge the penny and not the alligator clip.
20. Leave the penny submerged for 5 minutes.
21. After 3 minutes take the penny out
 - a. Weigh and record penny 2.
 - b. Describe the appearance of the penny.

Penny Weights (in grams)				
Penny 1			Penny 2	
Before Experiment	After Step 9	After Step 12	Before Experiment	After Experiment

- Based on the definitions above please describe which experiment is an example of a galvanic cell and which is an example of an electrolytic cell.
- List 3 things electroplating might be used for.
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- Using your data from experiment 2, use the following equation to calculate M.
Faraday's Law:

$$M = \frac{I * t * z}{n * F}$$

Where: I equals current (A)

t equals time (seconds)

z equals zinc at. Wt. (65.38 g/mole)

n equals valence electrons transferred

F equals 96485 C mol⁻¹

M equal mass of Zinc deposited in grams

Calculate M:

Calculate Faraday's Law finding I:

The Science: Describe what is going on with the electrons?

Why is this done? Give some real world examples