



## Let's Do Chemistry with the Penny!

### Introduction

We can do a lot of cool experiments with pennies. Pennies are copper-plated zinc coins, with about 2.5% of copper (Cu) per coin. It is the Cu that gives the reddish color to the penny. In this activity, we will observe what happens to the copper when we expose the penny to common household solutions of vinegar, salt, and water.

### Materials

- 3 pennies (NOTE: pennies dated before 1982 work best)
- ½ cup (118 mL) of white vinegar
- 3 small plastic cups or bowls and a marker for labels (write on a piece of tape if desired)
- 1 teaspoon (about 5 mL) of table salt (NaCl)
- three pieces of aluminum foil (½ inch x ½ inch, or 1.2 cm x 1.2 cm)
- three plastic spoons
- water
- timer or clock
- paper towels
- optional: iron nail, lemon juice, red vinegar, more salt

### Safety Suggestions

- Safety goggles required.
- Do not eat or drink any of the materials used in this activity.
- Thoroughly wash hands after this activity.
- Work with adult supervision.

### Procedure

1. Label the cups as follows:
  - a. water
  - b. water and vinegar
  - c. water, vinegar, and salt
2. Add ¼ cup (59 mL) of water to the first cup.
3. Add ¼ cup of vinegar to the second cup.
4. Add ¼ cup of vinegar and 1 teaspoon of salt to the third cup.
5. Add a penny to each of the three cups.
6. Observe what happens with the pennies in each of the solutions. Use the first table below to write down your observations at the beginning of the experiment.
7. After the period of time listed in the table, use a clean spoon for each cup to remove the pennies and place them on a paper towel.
8. Use the second table below to record your observations of the pennies on the paper towel.
9. Add one piece of aluminum foil to each of the cups.
10. Use the third table below to record your observations of what happens to the foil.

### How does it work? Where's the chemistry?

Most pennies that have been around for a while have dark spots of a compound called copper oxide. Copper oxide forms when the copper is oxidized by its reaction with oxygen in the air. Copper oxide dissolves in water, but it usually takes a long time.

The combination of vinegar (a weak solution of acetic acid), and table salt (sodium chloride) helps to dissolve the copper oxide, and also forms the blue copper(II) ion, which is soluble in water. The penny becomes shiny again!

Over time, you should observe that the pennies that were in the vinegar solutions reacted with oxygen in the air and formed a blue-green copper oxide compound, which is the same substance that we see on old copper statues and copper roofs.

As time goes by, small, red-orange particles will start to form on the surface of the aluminum foil. This is caused by the dissolved blue copper ions reacting with the aluminum, being reduced, and coming out of the solution as pure copper again! These copper atoms were originally on the pennies — then they dissolved in the solution, and now they are being deposited on the aluminum foil! If you wait long enough, the aluminum foil starts to fall apart, because the aluminum atoms are being oxidized to aluminum (III) ions and dissolving in the water!

**What did you experience?**

Describe each penny at the beginning. (What color is it? Does it have dark spots? Is it shiny or dull?)

	Cup with water	Cup with vinegar	Cup with vinegar and salt
Before you put it in the cup			
After 1 minute (min.) in the solution			
After 5 min. in the solution			
After 10 min. in the solution			
After 30 min. in the solution (if time allows)			
After 1 hour in the solution (if time allows)			

Describe each penny after you remove it from the cup. (What color is it? Does it have dark spots? Is it shiny or dull?)

	Penny from the cup with water	Penny from the cup with vinegar	Penny from the cup with vinegar and salt
After 1 min. on the paper towel			
After 5 min. on the paper towel			
After 10 min. on the paper towel			
After 30 min. on the paper towel (if time allows)			

After 1 hour on the paper towel (if time allows)			
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**You can do even more!**

You can repeat this experiment replacing the white vinegar with red vinegar or lemon juice. What do you see?

You can also add an iron nail to the solution instead of aluminum foil. How are things different?

**References**

<https://www.usmint.gov/learn/history/coin-production>

<https://www.usmint.gov/learn/coin-and-medal-programs/coin-specifications>

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