



ROBIN HOOD'S RICHES

CHALLENGE ACTIVITY

Robin Hood is famous for taking money from the rich and giving it to the poor. But he finds that his pennies are always dirty and even green looking. He hates to give away such ugly looking money.

Today, your challenge is to make Robin Hood's pennies look bright and new before he gives them to those in need.

Video link:

GETTING READY

Summary:

Have you ever wondered why some pennies are shiny and some are dull? It's not just a matter of how old the pennies are. Chemical reactions are responsible for the change in a penny's appearance over time. Today you will examine chemical reactions to see how oxygen can cause pennies to turn different colors.

Part 1 Active Time:

- 15-20 minutes

Part 2 Active Time:

- 15-20 minutes

Inactive Time:

- At least 8 hours for observation

Total Project Time:

- 1-2 days

Key Concepts:

Chemistry, Chemical reactions, Atoms, Oxidation

MATERIALS

You will need:

- Robin Hood's Riches Log Book pages (download or use your own notebook)
- 3 dull or dirty pennies
- ¼ cup white vinegar
- 1 tsp salt
- Measuring cups and spoons
- Paper Towel or Cotton cloth
- Non-metal bowl
- Small non-metal container with a lid
- Watch or timer

- Optional: acids such as lemon juice, orange juice, ketchup, soy sauce, hot sauce

BACKGROUND

Everything around you is made up of tiny particles called atoms. Some things are made up of just one kind of atom. The copper of a penny, for example, is made up of copper atoms. But sometimes atoms of different kinds join to make molecules. When different atoms combine and make a molecule, it is called a **chemical reaction**.

Copper atoms can combine with oxygen atoms from the air to make a molecule called copper oxide. Copper oxide is brownish or sometimes black in color (depending on other things in the penny's environment). The pennies looked dull and dirty because they are covered with copper oxide, not because they are covered in dirt.

To dig into the chemistry of this activity, we can go even further. Each individual atom is made up of smaller particles—electrons, protons, and neutrons. These are called subatomic particles. At the center of an atom is a nucleus. Protons carry a positive electrical charge, while neutrons carry no electrical charge and electrons carry a negative charge.

In the chemical reaction between copper and oxygen, electrons in the atoms move. In this case, when the oxygen is added, the negative electrons in the copper move to the oxygen. This transfer of electrons is called **oxidation**. **Oxidation** is the loss of electrons. When the copper bonds with the oxygen it forms copper oxide. The copper has lost some electrons, while the oxygen has gained some electrons. Copper changes color when it is **oxidized**.

PART 1: INSTRUCTIONS

Dull to Shiny

1. Pour $\frac{1}{4}$ cup white vinegar and 1 tsp salt into a small non-metal bowl and stir to dissolve.
2. Put pennies in the bowl and leave them for 30 seconds.
3. Remove the pennies and rinse with water.
4. Place on a paper towel or cloth to dry.

EXPLAIN

Pennies are made of copper or copper and zinc. When copper reacts with oxygen, copper oxide is formed. So when pennies sit out in the air for a long time, copper oxide build up on the surface and makes the pennies look dirty and dull.

Vinegar is acetic acid. When acetic acid mixes with salt (sodium chloride), new chemicals called sodium acetate and hydrogen chloride are made. These chemicals break down the copper oxide on the pennies so that they shine again.

PART 2: INSTRUCTIONS

Shiny to Green

1. Place a paper towel or cotton pad in the bottom of the non-metal container with the lid.
2. Wet the paper towel with a small amount of the white vinegar.
3. Put a penny on the wet pad and cover with the lid. The lid will keep the vinegar from drying out.
4. Put a penny on a dry paper towel or cotton pad.
5. Dip a penny in the salt/vinegar mixture and place it on a dry paper towel or cotton pad.

6. Wait and observe your pennies after 1, 2, 3 and 8 hours.
7. Make predictions and record your observations.

OPTIONAL: Try different acid/salt solutions such as lemon juice/salt, or ketchup.

8. Dip other pennies in various mixtures of acids and salt and record your observations.

EXPLAIN

You learned in Part 1 that pennies become dull and dirty when they sit in the air because their copper reacts with oxygen to form copper oxide on the surface. When the vinegar and salt dissolve the copper oxide layer, they make it easier for the copper atoms to bond with the oxygen from the air and the chlorine from the salt (sodium chloride) to make a green-blue compound called malachite. This is why you may see old pennies that look green.

EXPLORE



Where else have you seen metal objects that look green-blue?

Think about outdoor statues and sculptures made of metals such as the Statue of Liberty in New York, or the statues in your local park. Many statues are made of copper metals. Like pennies, they sit outside where they are exposed to oxygen, acids, and salt that exist in the air. Over a long time of exposure, malachite begins to cover the statue to make it look green.



Try this experiment using an old penny made before 1982, and using a penny made more recently. Pennies made before 1982 are made of all copper and will oxidize more, so the experiment will work better!



Try this experiment in Part 2, but replace vinegar with another acid such as lemon juice. What happens? Compare what happens to the penny in lemon juice and salt, to the one in vinegar and salt. Try again using ketchup, soy sauce, or hot sauce.

Learn more about inventing and find more activities on our website: www.fuelthepark.org.