Teacher Guide

Corrosion & Copper Activity

Introduction:
Over time, copper and copper alloys corrode in outdoor environments. Outdoor sculpture and architectural details made of copper or copper alloys can develop a patina of corrosion. This patina is sometimes considered attractive and desirable. But corrosion can also be damaging, destroying the surface and eventually the object as well as staining adjacent materials. This colorful mixture of compounds may have several components including copper oxides such as copper acetate. Historically, colored corrosion products have been used as pigments in paint. In this experiment, students will examine the corrosion of copper by an acidic environment. Students will cause the corrosion products to form and propose a balanced chemical equation for the corrosion of copper using acetic acid.

Objectives:

- Examine the way copper corrodes
- Write a balanced chemical equation for the formation of copper acetate

Note: This lab may be a precursor to the pigments lab, identifying the corrosion product as one of four historic pigments.

5th grade Science Georgia Performance Standards:

S5P2. Studentswillexplainthedifferencebetweenaphysicalchangeandachemicalchange.
c. Investigate the properties of a substance before, during, and after a chemical reaction to find evidence of change.

8th grade Science Georgia Performance Standards:

S8P1. Students will examine the scientific view of the nature of matter**.**
d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).

9-12th grade Science Georgia Performance Standards:

SPS2. Students will explore the nature of matter, its classifications, and its system for naming types of matter.
b. Predict formulas for stable binary ionic compounds based on balance of charges.
c. Use IUPAC nomenclature for transition between chemical names and chemical

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formulas of binary ionic compounds (containing representative elements) and binary covalent compounds (i.e. carbon dioxide, carbon tetrachloride).
e. Apply the Law of Conservation of Matter by balancing the following types of chemical equations: Synthesis, Decomposition, Single Replacement, and Double Replacement

SC1. Students will analyze the nature of matter and its classifications.

b. Identify substances based on chemical and physical properties.

SC2. Students will relate how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

a. Identify and balance the following types of chemical reactions:

- Synthesis
- Decomposition
- Single Replacement
- Double Replacement
- Combustion

Supplies (Per Group):

pennies or scraps of copper metal sheet
Large beaker (300 mL)
Small beaker (100 mL)
100 mL Graduated cylinder
Scoopula
Watch glass that will fit over the 300mL beaker
Small dish or container
Scalpel
Glass stirring rod
Balance
Weighing boat
Table salt (NaCl)
Acetic acid (CH_3COOH), 5%

Safety: Use caution when handling acid. Wear gloves and goggles.

Teacher Pre-Lab:

- Collect pennies from any date (both solid copper and copper plated types post 1982) will work in the chamber set-up. One penny per student or small group. Small pieces of copper sheet will work as well.

Procedures:

Part I: Corroding the copper

1. Obtain a penny or copper sample.
2. Measure 50 mL of the dilute acetic acid. Pour it into the 300 mL beaker. Measure 5 grams of sodium chloride and mix into the acetic acid.
3. Place your penny into the smaller beaker. Multiple pennies may be placed in one beaker provided that they do not overlap (3 will fit comfortably in a 100 mL beaker).
4. Gently place the smaller beaker containing the pennies into the larger beaker of acetic acid. Cover the larger beaker with a watch glass. You now have a small chamber where the acetic acid fumes will corrode the pennies.
5. Leave the chamber undisturbed for at least one week. Observe changes. Allowing the copper objects to be exposed for linger will produce more corrosion.

Part II: Observing the product

1. Using tweezers, retrieve a penny from the acetic acid chamber.
2. Observe the appearance of the corroded surface. Some pennies will have corroded more than others; is there a correlation to the date of the penny? Why might this be so?
3. Write a balanced chemical equation for the reaction of solid copper and acetic acid to produce copper acetate and hydrogen gas.

$$Cu + 2CH_3COOH \rightarrow + Cu(CH_3COO)_2 + H_2$$

Optional: Remove the corrosion product by gently scraping with a scalpel. Press lightly and move the blade parallel with the surface to remove the corrosion without disturbing the copper beneath it. Collect the corrosion product on a piece of filter paper and transfer the powder to a container. This corrosion product has historically been used as a pigment and can be identified through the Pigments Activity.

Clean up:

- Pennies can be reused multiple times and should be returned to the instructor.
- Properly dispose of acid from the chamber.

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Selected Resources:

- Deck, C. The Care and Preservation of Historical Brass and Bronze. Retrieved July 28, 2021 from: https://www.thehenryford.org/research/caring/brass.aspx

- Scott, D. A. (1994). An Examination of the Patina and Corrosion Morphology of Some Roman Bronzes. *Journal of the American Institute for Conservation*, *33*(1), 1–23. http://cool.conservation-us.org/jaic/articles/jaic33-01-001_indx.html