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The Statue of Liberty Laboratory Activity: The Chemistry of Copper

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The Statue of Liberty Laboratory Activity: The Chemistry of Copper (a Two-week period)

The Statue of Liberty, designed by French sculptor [Frédéric Auguste Bartholdi](#) and built by [Gustave Eiffel](#), is a gift from France on October 28, 1886. It is a colossal copper statue located on [Liberty Island](#) in [New York Harbor](#) in [New York City](#).¹ About 4.5 million people worldwide visit the Lady, Roman goddess, to have up-close personal experience.² However, gradually touched by wind and rain over more than a century, the shiny brown copper statue in reaction to the elements turned to the green color we recognize today, deteriorated by chemical reactions via acid/base and oxidation/reduction reactions. In 1986 the Statue was renovated for its centennial. The copper and brass industry provided technical guidance on the restoration, removing holes in the copper skin and layers of paint from the copper surface.³

The United States was founded on a set of ideals ([core values](#)), and one of those bedrock values is Liberty and is enshrined in the famous statue. It is no secret that since America's founding, each generation has struggled to live up to the basic principles and values espoused in our most cherished documents that lay the foundation for an American: Life, Liberty, and the Pursuit of Happiness. It is the pursuit of happiness that we endeavor to actualize for everyone in the United States, citizens and non-citizen alike. While the world is changing, American values largely remain a North Star for countless people worldwide, especially those who cherish freedom.

In this lab activity we will observe chemical changes of copper in acidic conditions, salt water, and a mixture of lemon juice and vinegar and salt; discuss whether the Statue of Liberty would hold as much cultural icon today had the Lady Statue remain the original shiny brown color.

Pre-lab Class Discussion:

1. Watch the following video (<https://phys.org/news/2017-06-video-statue-liberty-true.html>), and discuss (a) why the Lady we see today illuminates the rich green color (b) identify the chemical processes (changes) of this shiny brown color to the green color (c) the role of climate changes to the damage.

1. "Statue of Liberty National Monument." National Park Service. December 31, 2007.
2. "Statue of Liberty National Monument." New York City Landmark Preservation Commission. October 12, 2011.
3. "Restoring the Statue." National Park Service. February 26, 2015.

Materials:

Copper wire
0.1 M sulfuric acid
5 % Acetic acid (vinegar)
Lemon juice
pH paper
Salt water

Procedure:

1. Obtain six dry, clean test tubes. Label them A, B, C, D, E and F. Obtain 8 pieces of copper wire, record its appearance on your datasheet.
2. Add 4.0 mL of vinegar juice into the test tube A. Slowly place 1 piece of copper into the test tube A. Observe and record an initial chemical change in Table 1. Measure pH of the mixture and record it on your datasheet.
3. Make hypotheses on what will happen to the copper wire. Monitor and record the chemical reaction after 30 mins, and 2 days (or the next session), respectively. Please make sure to record observations, color change, gas formation, or any precipitation. Make hypotheses on what will happen to the wire in a week. Keep the test tube for the next lab period to observe any changes.
4. Repeat step 2 with 4.0 mL of lemon juice and 1 piece of copper into the test tube B.
5. Repeat step 2 with 4.0 mL of salt water and 1 piece of copper into the test tube C.
6. Repeat step 2 with 6.0 mL of a mixture of the lemon juice and salt water (1:1) and 1 piece of copper into the test tube D.
7. Repeat step 2 with 6.0 mL of a mixture of the vinegar and salt water (1:1) and 1 piece of copper into the test tube E.
8. Repeat step 2 with 6.0 mL of a mixture (lemon juice, vinegar, sulfuric acid and salt water (1:1:1:1)) and 2 pieces of Cu into the test tube F.
9. Record observations in Data Sheet Table 1. Work on the post-lab questions #4-8.

The second session (A week later)

10. Record observations in Data Sheet Table 1. Work on the post-lab questions #1-3. And submit your report.
11. Leave the test tubes in the hood for a longer period to monitor chemical changes.

Data Sheet

Name:

Reacting Cu with various solutions

1. Appearance of Cu:
2. Record any chemical changes took place

Table 1

		A	B	C	D	E	F
		Vinegar	Lemon juice	Salt water	Lemon juice and salt water (1:1)	Vinegar and salt water (1:1)	Mixture (lemon juice, vinegar and salt water, sulfuric acid 1:1:1:1)
	Describe evidence that a chemical reaction took place after 30 mins	pH =	pH =	pH =	pH =	pH =	pH =
	Describe, in detail, evidence that a chemical reaction took place after 2-3 days (or next lab session)	pH =	pH =	pH =	pH =	pH =	pH =

Post Lab Questions

1. Discuss chemical reactions in each of these reactions A, B, C, D, E and F.
2. Which solution oxidized the copper wire the slowest? Fastest?
3. Discuss the role of salt in the reaction.
4. The Statue of Liberty is made of copper. Discuss why copper is better suitable material for a statue than any other metals such as steel or iron.
5. Look up information about the restoration of the Statue of Liberty for its centennial in 1986. What role did oxidation-reduction play in the need for restoration?
6. What is acid rain? Discuss its causes and effects.

7. The Statue of Liberty museum opened on May 16, 2019. Read the following article and discuss the Statue's core idea, conceived by the legal thinker Edouard Rene Lefebvre de Laboulaye. <https://www.nytimes.com/2019/05/15/arts/design/statue-of-liberty-museum.html>

8. Do you think the Lady should remain green? Discuss your reasoning.

Higher Order Thinking: Culturally responsive teaching and learning

9. There are two parts to this assignment. (a) find a meme or a song lyric(s) that depicts the current state of [American values](#), broadly speaking, and explain if it supports or diverges from Emma Lazarus' message in [The New Colossus](#). Why does this meme or lyric best describe America's current viewpoint on immigration, and do you personally believe Lazarus' poem meaning has any merit in America today?

(b) The second part of this assignment highlights elected officials who are scientists; using the link to [Business Insider](#). Students will display graphically their differences with regard to gender, race/ethnicity, and [region](#) and write up a short description, 2-3 paragraphs, of the data. Is there any overlap between their campaign issue and their career before winning their congressional seat?