Discovering the Story: A City and Its Culture

Changing Silver

A Science Lesson for Grades 9-12 based on Vase and Dedication Medallion by Tiffany & Co.

Tiffany & Co. (1853-) Vase and Dedication Medallion, 1878
Silver
Bequest of Reuben R. Springer 1884.483

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CONCEPT

Teacher will guide the students through detailed scientific observations of physical properties, by examining the appearance of the sterling silver vase artifact. Students will learn about the scientific method and will explore chemical reactions employing silver and common household products. This activity allows students to use the scientific method to examine and identify a set of (nontoxic) substances that, through a chemical reaction, removes tarnish from silver. Once the characteristics of these substances are known, the students can use the information to draw inferences to identify that a chemical reaction has taken place.

OBJECTIVES

- Students will understand that the *Vase and Dedication Medallion* is a metal object with distinct physical and chemical properties.
- Students will identify the physical properties of silver through observation and guided discussions.
- Students will gain scientific understanding of the chemical change caused by tarnish or oxidation to silver.
- Students will experiment, analyze and evaluate observational data concerning the effective use of common household materials to remove tarnish (oxidation).
- Students will gain scientific understanding regarding tarnish (oxidation) as the result of chemical change on an elemental level.
- Students will gain an understanding of the function and artistic quality of the *Tiffany & Co. Vase and Dedication Medallion*.

"For the future of our children and our communities, we must find new ways to engage students in the learning process. The arts can be a powerful vehicle through which to challenge young people's minds, stir their creativity, instill discipline and build self-esteem."

Lawrence A. Hough
President and Chief Executive Officer
Sallie Mae

Teacher Preparation

Class Periods Required

1 (50–min.) class period for Pre-Lesson Activities
1 class period for Videoconference
2 to 3 class periods for Post-Lesson Activities

Background Information

Refer to Background Information for more on Reuben Springer and the Museum's *Vase and Dedication Medallion* and the company that created them. Background Information has been written for teachers to review before the lesson and then share with students and can be found online at http://www.discoveringthestory.org/goldenage/springer/background.asp.

Video

Share the *Vase and Dedication Medallion* video with your students prior to the videoconference. The video, which is on the website at http://www.discoveringthestory.org/goldenage/springer/video.asp, is an interview with a Museum curator on Reuben Springer and the *Vase and Dedication Medallion*. This video is an excellent resource that will help to prepare students for the videoconference.

Video Duration – five minutes.

"Music and the arts help children grow and learn in multiple ways, and they are vital to educating our nation's children."

Anne Dowling
President
The Texaco Foundation

Pre- Videoconference

Vocabulary

Definitions can be found in the Glossary on the *Discovering the Story* website at http://www.discoveringthestory.org/goldenage/springer/glossary.asp.

Acid
Base
Corrosion
Silver
Tarnish

Guiding Questions

- Does metal change over time or does it always look the same?
- The Museum's *Vase and Dedication Medallion* was given to Reuben Springer in the early nineteenth century; how do you think it has changed over the years?
- Why do you think the Museum has a glass case over the vase and medallion? What do you think is inside the case besides the vase?
- Would a silversmith like the one who made this vase and medallion need to know about science when he or she is working with silver to create a metal artwork?

Materials

- Reproduction of CAM *Tiffany & Co Vase and Dedication Medallion*, which can be downloaded at http://www.discoveringthestory.org/goldenage/springer/images/springer_full.jpg
- Pencils
- Group Observation Handout

Procedure

Teacher will:

- Ask the students to look at both *Vase and Dedication Medallion* and examine the beauty of each sterling silver artifact. The students should be informed that they were created in 1878. Students should be made aware that despite their age, they appear to look as they did when presented to Reuben Springer.

- Make students aware of tarnish and how it occurs.
- Begin a class discussion regarding the importance of crafting such a beautiful vase as a piece of art that is dedicated to honor Reuben Springer.
- Ask students why, if Tiffany & Company created such a magnificent vase and medallion, the artist would use silver metal instead of any other material. Do you believe that sterling silver was a good choice of material for this gift?
- Have students, as a class, create a list of questions regarding the Museum's *Vase and Dedication Medallion*, the patron of the arts Reuben Springer and/or the historical period. Email these questions to the Museum in advance of the videoconference.

"I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world."

Albert Einstein

Videoconference

Objectives

- Students will interact with the Cincinnati Art Museum staff through a sixty-minute videoconference. Information on the videoconference is on the website at http://www.discoveringthestory.org/videoconference/.
- Students will learn about Cincinnati history from 1850 to 1900.
- Students will use Museum objects to reinforce activities completed in preparation for this videoconference.

Concept

A videoconference conducted by the Cincinnati Art Museum staff extends student learning through emphasis on the viewing and discussion of art objects. During this videoconference with the Museum, students will explore Cincinnati art history and the methods and practices of many of the artists working in the city.

Schedule

- **5 minutes** Introduction to CAM staff *(This is also buffer time in case of connection complications)*
- **10 minutes** Brief discussion of student pre-videoconferencing activities.
- **10 minutes** Museum staff will lead an interactive discussion with students on the history of Cincinnati from 1850-1900
- **20 minutes** Museum staff will lead students in an in-depth investigation of selected Museum objects.

Objects Include

- *Bedstead* by Benn Pitman, Adelaide Nourse Pitman, and Elizabeth Nourse. http://www.discoveringthestory.org/goldenage/images/bedstead_full.jpg
- *Reception Dress* by Selina Cadwallader. This image can be found at http://www.discoveringthestory.org/goldenage/images/dress_full.jpg
- *Aladdin Vase* by Maria Longworth Nichols Storer, which is available at http://www.discoveringthestory.org/goldenage/images/aladdin_full.jpg
- *Ali Baba Vase* by M. Louise McLaughlin, which is available at http://www.discoveringthestory.org/goldenage/images/alibaba_full.jpg
- *Vase and Dedication Medallion* by Tiffany & Co. This image is on the Website at http://www.discoveringthestory.org/goldenage/images/springer_full.jpg

- **10 minutes** Questions and student sharing of art projects.
- **5 minutes** Closing *(This is also buffer time in case of connection complications)*

POST – VIDEOCONFERENCE

MATERIALS

- Tarnished piece of silver
- Pan or dish large enough to completely immerse the silver in
- Aluminum foil to cover the bottom of the pan
- Water to fill the pan
- Vessel for heating water
- Hot pads or kitchen mitts for handling the heated water vessel
- Baking soda, about 1 cup per gallon of water

PROCEDURE #1

Teacher will:

- Explain to students that if they have any objects made from silver or plated with silver, they know that the bright, shiny surface of silver gradually darkens and becomes less shiny. This happens because silver undergoes a chemical reaction with sulfur-containing substances in the air. They can use chemistry to reverse the tarnishing reaction, and make the silver shiny again.
- Line the bottom of the pan with aluminum foil. Set the silver object on top of the aluminum foil. Make sure the silver touches the aluminum.
- Heat the water to boiling. Remove it from the heat and place it in a sink. Add one cup baking soda per gallon of hot water. The mixture will froth a bit and may spill over; this is why you put it in the sink.
- Pour the hot baking soda and water mixture into the pan and completely cover the silver.
- Point out that almost immediately, the tarnish will begin to disappear. If the silver is only lightly tarnished, all of the tarnish will disappear within several minutes. If the silver is badly tarnished, you may need to reheat the baking soda and water mixture, and give the silver several treatments to remove all of the tarnish.

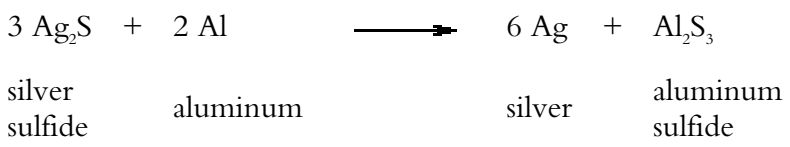
EXPLANATION

When silver tarnishes, it combines with sulfur and forms silver sulfide. Silver sulfide is black. When a thin coating of silver sulfide forms on the surface of silver, it darkens the silver. The silver can be returned to its former luster by removing the silver sulfide coating from the surface.

There are two ways to remove the coating of silver sulfide. One way is to remove the silver sulfide from the surface. The other is to reverse the chemical reaction and turn silver sulfide back

into silver. In the first method, some silver is removed in the process of polishing. In the second, the silver remains in place. Silver polishes that contain an abrasive shine the silver by rubbing off the silver sulfide and some of the silver along with it. Another kind of tarnish remover dissolves the silver sulfide in a liquid. These polishes are used by dipping the silver into the liquid, or by rubbing the liquid on with a cloth and washing it off. These polishes also remove some of the silver.

The tarnish-removal method used in this experiment uses a chemical reaction to convert the silver sulfide back into silver. This does not remove any of the silver. Many metals in addition to silver form compounds with sulfur. Some of them have a greater affinity for sulfur than silver does. Aluminum is such a metal. In this experiment, the silver sulfide reacts with aluminum. In the reaction, sulfur atoms are transferred from silver to aluminum, freeing the silver metal and forming aluminum sulfide. Chemists represent this reaction with a chemical equation.



The reaction between silver sulfide and aluminum takes place when the two are in contact while they are immersed in a baking soda solution. The reaction is faster when the solution is warm. The solution carries the sulfur from the silver to the aluminum. The aluminum sulfide may adhere to the aluminum foil, or it may form tiny, pale yellow flakes in the bottom of the pan. The silver and aluminum must be in contact with each other, because a small electric current flows between them during the reaction. This type of reaction, which involves an electric current, is called an electrochemical reaction. Reactions of this type are used in batteries to produce electricity.

PROCEDURE #2

DISCUSSION

- What could you do to remove oxygen in the form of black oxide (called tarnish) from a silver spoon so that it looks new again? (What kind of atom could you use to combine with the oxygen in a chemical reaction?)
- What kind of molecule would be formed?

EXPLANATION

You were correct if you said that hydrogen can combine with oxygen in the oxide to form water (H_2O). Tarnish remover is a watery paste, and many molecules in water solutions break up into positively and negatively charged pieces called ions.

Metal atoms and hydrogen atoms form positive ions while nonmetal atoms generally form negative ions. Thus, positive hydrogen ions (H^{1+}) combine with negative oxide (O^{2-}) ions to form neutral water (H_2O). Silver metal for example has a blackish color, whereas its silver ion in water is blue. We will be using three different weak acids in the next activity to supply hydrogen (H^{1+})

ions to remove tarnish. An **acid** is a chemical that releases hydrogen ions in water. The acids that we will use are (a) hydrochloric acid ($H^{1+}Cl^{1-}$) used in cleaning bricks and also called muriatic acid, (b) vinegar ($CH_3COO^{1-}H^{1+}$) used in cooking and (c) water (H_2O).

We generally don't think of water as an acid, but it does provide H^{1+} ions. Think of it as a very, very, very weak acid.

Ask students:
Which liquid do you think is the strongest acid, providing the most H^{1+} ions and therefore is the best cleaner of oxides from metals? Why?
a. hydrochloric acid ($H^{1+}Cl^{1-}$)
b. vinegar ($CH_3COO^{1-}H^{1+}$)
c. water (H_2O)

MATERIALS

Three blackened silver spoons
Liquids: water, vinegar, diluted HCl acid (0.1M concentration)
Eyedroppers or Beral pipettes for each liquid
Toothpicks for stirring

PROCEDURE

Teacher will:
Place three well-used, blackened silver spoons in a row, then put a drop from a different liquid on each spoon. Use a toothpick to stir to help the reaction between H^{1+} ions and the black oxide on the spoon. Record your observation in the table below.

Data Table: Combination of H^{1+} ions with Oxide (O^{2-}) Ions in Silver oxide

Source of H^{1+} ions	Observations	Oxide Removal (none / better / best)
Water H_2O		
Vinegar $CH_3COO^{1-}H^{1+}$		
Muriatic acid: $H^{1+}Cl^{1-}$		

- All three solutions contain hydrogen ions. Based on the above results, which solution has the strongest concentration of hydrogen ions? Explain.
- Use small circles with the Ag symbol inside, a darkened circle for O, a smaller circle with H inside, and a very small H inside a circle with a + sign for H^{1+} ions to draw the pictures below.

- Use the information above to complete the equations of the removal of the oxide in silver oxide to produce water and silver atoms. Use the circles of atoms and molecules for the picture portion of the equation.

	reactants			→	products		
word equation		+		→		+	
chemical equation		+		→		+	
colors of chemicals		+		→		+	
picture drawings		+		→		+	

Assessment Objectives

- Students can communicate science explanations, ideas and conclusions to classmates and teacher.
- Students analyze and synthesize data and defend conclusions.
- Students have developed understanding, ability, values of inquiry and knowledge of science content.
- Students can apply the results of experiments to scientific arguments and explanations.
- Students manage ideas and information.

Extension Activity

How much would a coin be worth if it were made of pure silver?

Objectives

- Find out why we have "sandwich" coins.
- Work with a balance scale.
- Work with their multiplication skills.

Materials

One set of coins per group: pennies, nickels, dimes and quarters (half dollars, Susan B. Anthony silver dollars and large silver dollars if available)
One balance scale per group
Newspaper or the Internet to determine the current price for one ounce of silver

Procedure

- The students should first use the balance scale to find the mass of each coin in grams.
- The students should then find out how much one gram of silver is worth by dividing the price of one ounce of silver by the number of grams in one ounce of silver (1 ounce = 28.35 grams).
- The students then will multiply the mass of the coin in grams by the value of one gram of silver to find out how much the coin would be worth if it were pure silver.
- Find out the current price of silver. (Helpful websites: http://www.monex.com/, http://www.kitco.com/charts/livesilver.html, http://apmex.com/)
- The students can then make a color-coded, double bar graph showing the current value of the coin compared to the value of the coin if it were made of pure silver.
- Make sure that students know that copper has a much lower value than silver.
- For more extraordinary results, try gold.

Academic Content Standards

National Standards: Science

Standard 12: Understands the nature of scientific inquiry.

Benchmark 2: Designs and conducts scientific investigations (e.g., formulates testable hypotheses; identifies and clarifies the method, controls and variables; analyzes, organizes and displays data; revises methods and explanations; presents results; receives critical response from others).

OHIO STANDARDS: SCIENCE

Standard: Physical Sciences
Students demonstrate an understanding of the composition of physical systems and the concepts and principles that describe and predict physical interactions and events in the natural world. This includes demonstrating an understanding of the structure and properties of matter, the properties of materials and objects, chemical reactions and the conservation of matter. In addition, it includes understanding the nature, transfer and conservation of energy; motion and the forces affecting motion; and the nature of waves and interactions of matter and energy. Students demonstrate an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with the physical sciences.

Grades 9-10

Benchmark A: Describes that matter is made of minute particles called atoms, and atoms are comprised of even smaller components. Explains the structure and properties of atoms.

Benchmark B: Explains how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.

Grades 11-12

Benchmark A: Explains how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena.

Benchmark B: Recognizes that some atomic nuclei are unstable and will spontaneously break down.

Standard: Scientific Inquiry
Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and make predictions. They are able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Grades 9-10

Benchmark A: Participates in and applies the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations.

Grades 11-12

Benchmark A: Makes appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.