Finding Safer Substitutes

CONTENT AREAS

- **Science**
  acids/bases, scientific method

OBJECTIVES

Students will…

- recognize that many hazardous household chemicals are not necessary
- prepare, test and evaluate the effectiveness of alternative silver metal cleaners

MATERIALS

For each group of two or three students

- Safer Substitutes Worksheet
- commercial silver polish
- 2 tarnished silver items (dimes will work; don't use valuables or antiques)
- dab of white toothpaste
- drop of olive oil
- soft, nonabrasive cloths
- large beakers or glass or plastic bowls large enough to hold the silver items
- piece of aluminum foil sized to fit container bottom
- 1 tablespoon salt
- 1 tablespoon baking soda
- water
- kitchen measuring spoons
- safety glasses

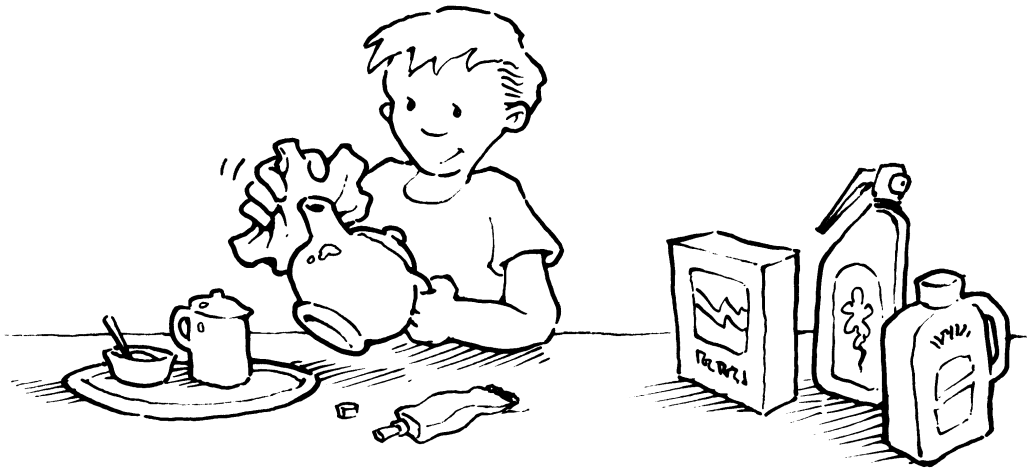
TIME

Two periods, *45 minutes each*

Many common household products are not only hazardous, but they are also often expensive and unnecessary. Commercial silver cleaners and polishes remove and prevent tarnish. They usually contain acids, ammonia derivatives, surfactants, mild abrasives and anti-tarnish ingredients, such as wax or polyethylene glycol. All of these chemicals are classified as irritants. Acid fumes cause headaches and some are flammable. All are corrosive and toxic.

Simple washing and wiping with soap and water will not remove the tarnish. Scouring with harsh abrasives or steel wool pads will permanently scratch and scar the soft metal. However, safe, effective and less expensive alternatives can often be found in most grocery stores. Most rely on the action of natural acids such as citric acid from lemons, or lactic acid from sour milk.

In this activity, students test two, safe alternatives for cleaning silver. One uses toothpaste and the other uses baking soda, salt, and aluminum foil.



PROCEDURE

1. Show students a tarnished silver item that, when viewed from a distance, is difficult to distinguish as silver. Ask students to tell you what it is made of. Discuss why they may have had trouble telling it was silver.

2. Ask students how they could get it clean. Would ordinary methods, such as wiping with soap and water or using an abrasive scouring pad, work? Why or why not? Invite a student to try one of these methods. Discuss why this method did not work. (See Teacher Notes for answers.)

3. Display a sample of silver polish and reveal its ingredients and possible health affects. Ask the class to assign it a hazardous materials classification code (see Teacher Notes).

4. Discuss any alternatives to the harsh chemicals that students suggest. Students may not have any alternatives, but if there are suggestions, discuss how you could test each.

5. Inform students they will test and evaluate two alternatives in class. Divide the class into groups of two or three students. Give each group two tarnished silver items and a copy of the Safer Substitutes Worksheet.

6. Have students clean one object with Alternative Method A:

   a. Place a small amount of white toothpaste directly on the object.

   b. With a soft cloth or rag, work the paste onto the surface of the object, concentrating on the heavily tarnished areas. Using a drop of olive oil will make the toothpaste spread more easily. As the tarnish begins to disappear, the toothpaste will turn grey and you may detect a slight smell of sulfur. Can you explain the smell? (See Teacher Notes.)

   c. Allow the paste to dry. Rinse it off with hot water. Buff the object dry with a clean, soft cloth. (See Extension #6 for help in tarnishing a silver item.

7. Have students clean the other object with Alternative Method B:

   a. Fill the glass or plastic container with enough water to completely cover the silver item, but do not put the item in the water.

   b. Mix 1 tablespoon of salt and 1 tablespoon of baking soda into the water. Observe and note the properties of the solution.

   c. Cut a sheet of foil to fit into the bottom of the container. Carefully observe the foil before adding it to the container. Sink it to the bottom.

   d. Add the silver item and let it stand several hours or overnight.

   e. Remove the object, rinse, dry and observe.

   f. Observe the aluminum foil. How has it changed? Can you explain this? Observe the solution. Has it changed? (See Teacher Notes.)

   g. Recycle the aluminum foil and pour the solution down the drain.

8. As a teacher demonstration, clean a silver object with the commercial silver polish. Have the students observe it and make comparisons.

   Alternatively, if there are enough gloves and polish, have the students clean a third item.

QUESTIONS

When the activity and worksheets are complete, discuss students' answers to the worksheet questions. Also discuss how/why each method works.

a. Why are alternative methods preferable to commercial products?

b. Were the alternative methods as effective as the commercial products?

c. Which method was the most expensive? Which was the cheapest?

d. Which method took the most time?

e. Which method was the messiest?

f. Which method is the best in terms of source reduction?

EXTENSIONS

1. Calculate the cost of commercial silver polish versus alternatives A and B.

2. Find alternatives to other polishes. Test them. How effective are they? Why do they work? Test each alternative to see if it is an acid or a base. Which work best? (See Teacher Notes.)

3. Test the alternatives listed in Activity 9 against their commercial counterparts.

4. Silver should be stored in a tightly wrapped, soft cloth. Why does this help prevent tarnish? Research why silver tarnishes and exactly what tarnish is.

5. As a class demonstration or at-home lab, test this old-fashioned cleaning method. Put the tarnished silver in a plastic or glass bowl or dish. Add enough sour milk or buttermilk to cover it. Let it soak overnight. Rinse, buff and dry the silver. If no sour milk or buttermilk is available, add either cream of tartar, vinegar or lemon juice to whole milk. Why do these methods work? (All of the mixtures contain natural acids.)

6. As a reverse, take a clean silver item and expose it to raw egg yolk or mustard. Allow the yolk to dry and then clean it off. The silver item turns black. Why? (Eggs and mustard contain sulfur. Silver reacts with hydrogen sulfide.)

7. Give extra credit to students who research why silver tarnishes and write out the chemical equation for the reaction.

Teacher Notes

Metals tarnish or discolor when they are exposed to moisture and the atmosphere. Silver, for example, reacts to airborne traces of hydrogen sulfide. The hydrogen sulfide combines with the silver to form a brownish black coating of silver sulfide. (That's why cooking and eating utensils tarnish if they are brought in contact with foods that contain sulfur, such as eggs or mustard.)

Commercial silver cleaners and polishes remove and prevent tarnish. They usually contain acids, ammonia derivatives, surfactants, mild abrasives and anti-tarnish ingredients, such as wax or polyethylene glycol. All of these chemicals are classified as irritants. Acid fumes may cause headaches and some are flammable. All are corrosive and toxic.

Multi-purpose metal cleaners usually contain abrasives, harsh acids, ammonia, alcohol and water. Ammonia vapors are potentially harmful, and all of these chemicals are both toxic and irritating to the skin and eyes.

Acid is an important ingredient because many metals react with acids, releasing hydrogen gas when it is applied. The metals replace the hydrogen in the acid, and the reaction can often be seen as tiny bubbles or fizzing. Safe, natural acids from lemons, sour milk, yogurt, ketchup or white vinegar all make fine substitutes if given ample time to work.

Simple washing and wiping with soap and water will not remove the tarnish. Scouring with harsh abrasives or steel wool pads will permanently scratch and scar the soft metal. However, safe substitutes can be found that work very well. Most rely on the action of natural acids, such as citric acid from lemons or lactic acid from sour milk. Toothpaste is mildly abrasive.

In using baking soda, salt, and aluminum foil, a replacement chemical reaction results. Because aluminum is more reactive than silver, the sulfide is loosened from the silver and combines with the more reactive aluminum, turning the foil blackish brown and cleaning the silver.

The baking soda prevents the formation of a protective oxide coating on the aluminum. The process is more rapid with the presence of salts because they make the water more conductive.

Safer Substitutes Worksheet

1. Write a detailed observation of each object, noting where the tarnish is heaviest before beginning to clean.

Object 1

Object 2

2. Clean one object with Alternative Method A.

a. Place a small amount of white toothpaste directly on the object.

b. With a soft cloth or rag, work the paste onto the surface of the object, concentrating on the heavily tarnished areas. Using a drop of olive oil will make the toothpaste spread more easily. As the tarnish begins to disappear, the toothpaste will turn grey and you may detect a slight smell of sulfur. Can you explain the smell?

c. Allow the paste to dry. Rinse it off with hot water. Buff the object dry with a clean, soft cloth.

3. Clean the other object with Alternative Method B:

a. Fill the glass or plastic container with enough water to completely cover the silver item, but do not put the item in the water.

b. To each 240 ml of water, mix in 1 tablespoon of salt and 1 tablespoon of baking soda. Observe and note the properties of the solution.

c. Cut a sheet of foil to fit the bottom of the container. Carefully observe the foil before adding it to the container. Sink it to the bottom.

d. Add the silver item and let it stand overnight.

e. The next day, remove the object, rinse, dry and observe.

f. Observe the aluminum foil. How has it changed? Can you explain this? Observe the solution. Has it changed?

g. Recycle the aluminum foil and pour the solution down the drain.

QUESTIONS

After completing the procedure for each method, examine the objects and answer these questions:

a. How do the objects compare with their original descriptions?

b. Is each method effective as a substitute? Explain.

c. Does either method involve hazardous properties? If so, which ones?

d. How do the ingredients of the alternative methods compare with the ingredients of the commercial silver polish?