

# The Tarnished Truth

Although silver utensils are generally quite attractive, over time they become tarnished as they react with sulfur in the air or in certain foods. You may have had the dubious pleasure of polishing silver and learned that the tarnish is very stable and not easily removed. A common method of cleaning silver is to use an expensive cleaner that removes the tarnish (along with some silver) by abrasion. There is another way to restore the luster that uses less expensive materials, takes less effort, and has another benefit. What do you think it might be?

## Materials

- silver or silver-plated utensil
- new iron nail
- inexpensive aluminum pie pan
- hard-boiled egg or egg-containing mayonnaise
- near-boiling water
- teaspoon baking soda
- teaspoon table salt
- wooden stirrer
- tongs
- teaspoon measure

## Safety

Near-boiling water can cause severe burns—handle with care.

## Exploration

- Step 1 Describe the surface finish of the silver utensil and nail. If using a hard-boiled egg, peel it and push the silver utensil and the iron nail into it; leave this way overnight. If using mayonnaise, spread the mayonnaise over the utensil and nail and leave on overnight.
- Step 2 Remove the egg or mayonnaise from the utensil and nail. Record the appearance of the utensil and nail. Thoroughly rinse them with water and wipe dry. Does this significantly affect their appearance? What is the substance on the utensil's surface? What is the substance on the nail's surface?
- Step 3 Half-fill the aluminum pie pan with near-boiling water. Add one teaspoon baking soda and one teaspoon table salt; stir to dissolve. Place the utensil and nail in the pan and observe the pan and the contents for several minutes. Remove the utensil and nail with the tongs. Describe the appearance of the utensil, nail, and inside of the pan.

Step 4 This method of cleaning the tarnished silver is an electrochemical process. What type of reaction is occurring? Write the equations representing the half-reactions and the overall equation for the process. Why would you not want to use a good aluminum pan for this activity? What is the other benefit of this method referred to in the introductory remarks? From your observations, what can be concluded about the relative reactivities of silver, iron, and aluminum?

### **Challenge**

How can you use household products to reverse the process of silver tarnishing?

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## Concepts

oxidation-reduction reaction, electrochemical cell

## Expected Student Responses to Exploration

Step 1 Both appear lustrous.

Step 2 (a) Both the utensil and the nail appear dark.

(b) Rinsing well does not significantly affect their appearance.

(c) Silver (I) sulfide has formed on the utensil.

(d) Iron sulfide has formed on the nail.

Step 3 The utensil is shiny, the nail remains dark, and the pan is dark and/or pitted.

Step 4 (a) An oxidation-reduction reaction is occurring.

(b)  $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$

$\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$

$3\text{Ag}_2\text{S}(\text{s}) + 2\text{Al}(\text{s}) \rightarrow 6\text{Ag}(\text{s}) + \text{Al}_2\text{S}_3(\text{s})$

(c) Because the pan is damaged as the aluminum reacts.

(d) No silver is lost in this process; silver is lost when silver polish is used.

(e) The increasing order of reactivity is  $\text{Ag} < \text{Al} < \text{Fe}$ .

## Expected Student Answer to Challenge

The process can be reversed by reacting the tarnish with aluminum in a hot salt and baking soda solution.

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