Silver Water
Creating a Silver Mirrored Flask

Abstract

Combine several solutions in a clean Florence flask. Stopper and swirl the flask. Within minutes, a beautiful silver reflective mirror coating forms on the inside of the flask, from the reduction of silver ions to silver metal.

Materials

1.5 M Ammonium Nitrate solution
2.5 M Sodium hydroxide solution
0.5 M Silver Nitrate solution
Acetone
5% Dextrose Solution
Disposable Gloves
Large 20-gallon bucket ¾ filled with H_2O
4-Graduated Cylinders 50 mL
1000 mL Florence Flask
1-Beaker 100 mL
Milli-Q Water Bottle
#8 Stopper to fit 1000 mL flask
Safety Goggles
2- 50 mL storage bottles

Safety

Silver nitrate is extremely toxic. It can cause severe burns along with discoloration of the skin and clothing. It could result in corneal damage, even blindness, if splashed into the eyes. Ammonium nitrate is also toxic. Care must be taken in avoiding contact with skin, eyes, and lungs. Contact with other chemicals or heat could result in fire or explosion. Sodium hydroxide is a corrosive material. Mixing the materials in this experiment has the potential to form an explosive compound. When the silvered flask has been produced, empty the contents immediately into a large bucket filled with fresh distilled water. Rinse the flask at least three times into the same bucket. Dispose of the water in the bucket immediately. Always wear disposable gloves and safety goggles when conducting the experiment.

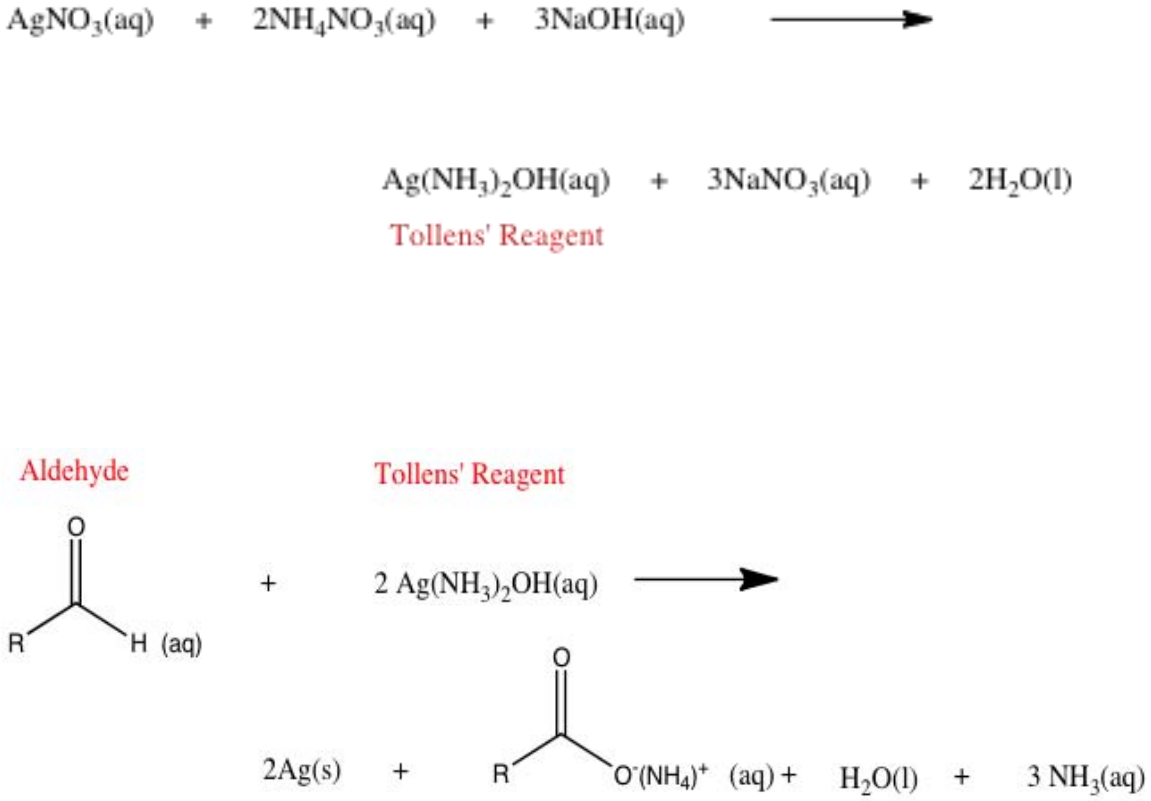
Procedure

Make sure that the flask is clean. If the flask is dirty, the metallic silver coating may not adhere to the walls resulting in poor results. Prior to starting the experiment, take a few moments to rinse out the flask with a little acetone and then carefully dry it out. Place 40 mL of 5% dextrose solution directly into the 1000 mL Florence flask and stopper it. In a 100 mL beaker mix together 20 mL of the 1.5M ammonium nitrate solution and 20 mL of the 0.5M silver nitrate solution. Carefully measure out each of these solutions with a clean 50 mL graduated cylinder. Now pour this freshly prepared solution into a clear bottle labeled Solution 1 and set it aside. Take another 50 mL storage bottle and add 40 mL of 2.5M sodium hydroxide solution and label this bottle Solution 2. When you perform the demo, take the stopper out of the 1000 mL Florence flask and in quick succession add Solution 1 first and then Solution 2. Immediately put the stopper on the flask. Start to gently rotate the flask making sure that every part of the flask is coated with the solution. Continue rotating the flask constantly in your hands swirling it making sure the entire flask is wet with solution. After a few minutes of rotating, the entire flask should be coated with a reflective silver mirror finish. Immediately remove the stopper from the flask and pour any remaining liquid into the 20-gallon bucket, which is ¾ filled with water. Use a water bottle to rinse your reaction flask three times, pouring the contents of these rinsings into the same bucket. The liquid in the bucket should be immediately poured down the drain with large amounts of water. This is the only way to prevent the formation of any explosive compounds, which could potentially form if the reaction solutions are allowed to sit for any period of time. To fix the flask and use it as a vase you could coat the inside with some clear nail polish which will help to preserve the metallic silver coating adhering to the walls of the flask and prevent it from eventually falling off if exposed to liquids.

Discussion

This classic demonstration is used in the lab today as a qualitative test to detect the presence or absence of aldehyde groups in a molecule. We reacted dextrose with a silver complex Tollens' Reagent [$Ag(NH_3)^{2+}$], which is present in a basic aqueous mixture. The sugar was immediately oxidized to a carboxylic acid and acted as a reducing agent on the silver in Tollens' reagent reducing the silver ions [Ag+] to silver metal [Ag]. The metal deposits on the inside of our flask as a reflective mirror surface. This is precisely how silver mirrors are still made today. The silvering process was discovered in the 19th century by a German chemist Justus von Liebig.

The reaction scheme is shown below:



Disposal

The mixture remaining in the bucket must be properly flushed down the drain immediately after the reaction is complete using excessive amounts of water and following all local and state regulations for the disposal. See Flinn Scientific Disposal Method #26b. Dispose of following all local, state and federal regulations for disposal.

References

Summerlin, L. R., Ealy, J. L., Jr. *Chemical Demonstrations*, American Chemical Society: Washington, D. C., **1988**, p. 91.

Cesa, I., Editor, *Flinn ChemTopic Labs, Oxidation and Reduction*, Flinn Scientific: Batavia Il (**2004**).

Shakhashiri, B. Z. *Chemical Demonstration: A Handbook for Teachers of Chemistry*; The University of Wisconsin: Madison, **1992**; Vol. 4, p. 240-243.

Chemistry Behind the Magic: Chemical Demonstrations for the Classroom

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