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The Mirrored Flask

A Silver Mirror Lab

Introduction

Demonstrate the magic of chemistry by turning an ordinary flask into a beautiful silver mirror.

Concepts

- Oxidation–reduction
- Aldehyde reactivity
- Tollens' test

Materials (to coat the inside of one 250-mL flask)

Ammonium hydroxide, NH_4OH , concentrated, 2.5–4 mL	Beaker, 150-mL
Dextrose, $\text{C}_6\text{H}_{12}\text{O}_6$, 0.25 M, 10 mL (4.5 g in 100 mL DI H_2O)	Beaker, 1000-mL (for waste)
Potassium hydroxide, KOH, 0.80 M, 15 mL (4.5 g in 100 mL DI H_2O)	Beral pipets or eyedroppers
Silver nitrate, AgNO_3 , 0.10 M, 30 mL (1.7 g in 100 mL DI H_2O)	Graduated cylinder, 10-mL
Flask with cap, volumetric, Florence or other 250-mL flask	Graduated cylinder, 50-mL
Tap water	Stirring rod

Safety Precautions

Silver nitrate is corrosive; causes burns; will stain skin and clothing; highly toxic; avoid contact with eyes and skin. Potassium hydroxide is corrosive; causes burns; much heat evolves when added to water; very dangerous to skin and eyes. Ammonium hydroxide is a serious respiratory hazard; toxic by ingestion; skin, eye and respiratory irritant. Wear chemical-resistant apron, chemical-resistant gloves and chemical splash goggles. Please review current Material Safety Data Sheets for additional safety, handling and disposal information. Immediately dispose of the unreacted mixture. Explosive fulminating silver compounds may form if the unreacted mixture is allowed to stand.

Procedure

1. Fill a 1000-mL beaker $\frac{3}{4}$ -full with water.
2. Add 10 mL of the 0.25 M dextrose solution to a clean 250-mL Florence flask.
3. Add 30 mL of 0.10 M silver nitrate solution to a 150-mL beaker.
4. While stirring, add concentrated ammonium hydroxide dropwise to the silver nitrate solution in the beaker until the gray-black silver hydroxide, AgOH , precipitate forms. Continue adding concentrated ammonium hydroxide dropwise with swirling until the silver diammine ionic complex, $\text{Ag}(\text{NH}_3)_2^+(\text{aq})$, forms and the solution JUST becomes clear and colorless.
5. Add 15 mL of the 0.80 M potassium hydroxide solution to the beaker. The silver hydroxide solid usually precipitates again, so add concentrated ammonium hydroxide dropwise with swirling until the solution just clears.
6. Pour the contents of the beaker into the 250-mL flask, insert a stopper or cap, and swirl gently so the liquid contacts the entire inner surface of the flask, including the neck. Continue to swirl and within 5 minutes, the entire flask will be coated with a silver mirror surface.
7. Pour the liquid in the flask down into the 1000-mL water-filled waste beaker. Rinse the flask thoroughly with water. This step is very important and must be done immediately to prevent the possible formation of an explosive mixture. Follow appropriate disposal procedure.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The final solution may be rinsed down the drain with a 20-fold excess of water according to Flinn Suggested Disposal Method #26b. Excess silver nitrate solution may be precipitated according to Flinn Suggested Disposal Method #11. Excess potassium hydroxide and ammonium hydroxide solutions may be neutralized according to Flinn Suggested Disposal Method #10. Excess dextrose solution may be rinsed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Process: Grades K–12

Evidence, models, and exploration
Constancy, change, and measurement

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter

Content Standards: Grades 9–12

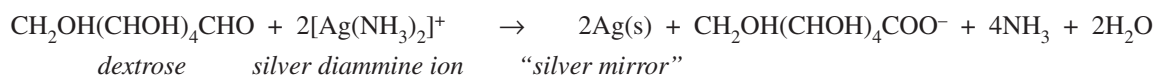
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Tips

- Always mix the chemicals fresh and dispose of them immediately after use with large amounts of water. The mixed chemicals may form an explosive precipitate if heated and then stored for several hours.
- This lab will work best by using a brand new flask. Used flasks may have scratches in the glass which tend to cause the silver layer to peel. A volumetric flask with a snap-on cap or a Florence flask with a stopper works well.
- The silver coating on the inside of the flask (or test tube) may be protected from oxidation and mechanical stress by coating it with either a clear varnish or paint. The coating may be applied by pouring about 50 mL of water-based varnish or paint into the flask, turning the flask to coat its entire interior surface, pouring out the excess, and allowing the coating to dry.

Discussion

The silver-producing reaction in this activity is one that is commonly used in qualitative organic analysis to identify aldehydes. The reaction called the “Silver Mirror Test” or Tollens’ Test, is performed by mixing aqueous silver nitrate with aqueous ammonia to produce a solution known as Tollens’ reagent. The reagent contains the silver diammine ion, $\text{Ag}(\text{NH}_3)_2^+$. Although this ion is a very weak oxidizing agent, it will oxidize the aldehyde functional group ($-\text{CHO}$) of dextrose, a reducing sugar, to a carboxylate ion ($-\text{COO}^-$). As this oxidation occurs, silver is reduced from the +1 oxidation state to metallic silver. The metallic silver is deposited on the walls of the flask in the form of a reflective “mirror.” The overall reaction occurs as follows:



References

Bush, K. J. and Diehl, H. J. *Chem. Educ.* **1979**, 56, 54.

Shakhashiri, B. Z. *Chemical Demonstrations: A Handbook for Teachers in Chemistry*; University of Wisconsin: Madison, 1992; Vol. 4, pp 240–243.

Materials for *The Mirrored Flask* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0025	Silver Nitrate, 25 g
D0002	Dextrose, Anhydrous, 500 g
P0058	Potassium Hydroxide, 100 g
A0174	Ammonium Hydroxide, 100 g
GP4035	Volumetric Flask with Snap-on Cap

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.