Heigh-Ho Silver!

Make Your Own Silver Test Tube

FLINN SCIENTIFIC CHEMFAX!

Introduction

In this rewarding activity, students can make their own microsize silver test tubes using a popular qualitative analysis procedure called Tollens' test.

Concepts

- Oxidation–reduction
- Reducing sugars
- Tollens' test

Materials

Acetone (optional)
Ammonium nitrate solution, NH_4NO_3, 12%, 4 drops
Dextrose solution, $C_6H_{12}O_6$, 5%, 8 drops
Nitric acid, HNO_3, 6 M (optional)
Silver nitrate solution, $AgNO_3$, 8%, 4 drops
Sodium hydroxide solution, NaOH, 10%, 8 drops
Distilled water
Beaker, 400-mL (for waste)
Beral pipets, 8
Culture tube, glass, 6 × 50 mm
Parafilm®, 3 × 3 cm

Safety Precautions

Sodium hydroxide solution is a corrosive liquid and is especially dangerous to the eyes. Silver nitrate solution is toxic by ingestion and will stain skin and clothing. The mixed solution in the flask may form a potentially explosive material if left standing and allowed to dry. Do NOT mix the solutions beforehand—add them together in the test tube and follow the instructor's directions for disposing of the leftover solution immediately after use. Rinse with copious amounts of water. Avoid contact of all chemicals with eyes and skin. Wear chemical splash goggles and chemical-resistant gloves and apron. Wash hands thoroughly with soap and water before leaving the lab. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

All solutions are prepared as weight–volume percent solutions. *Example:* Prepare 8% silver nitrate solution by dissolving 8 g of silver nitrate in 80 mL of distilled or deionized water. Dilute to a final volume of 100 mL with water.

Procedure

1. Fill a 400-mL beaker approximately three-quarters full with water.
2. Obtain a glass culture tube and add the following amounts of each solution to it in the order indicated (a–d):
   a. 8 drops of 10% sodium hydroxide solution
   b. 8 drops of 5% dextrose solution
   c. 4 drops of 12% ammonium nitrate solution
   d. 4 drops of 8% silver nitrate solution
3. Place a square of Parafilm over the culture tube and gently shake the tube for about 3 minutes.
4. After the inside of the test tube is coated with a silver "mirror," pour any solution remaining in the culture tube into the beaker filled with water. This is an important safety precaution to prevent the possible formation of a potentially explosive, unstable mixture.
5. Rinse the silvered test tube with distilled water three times. Allow the test tube to air dry.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Immediately dispose of the final solution (step 4) by rinsing down the drain with

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a 20-fold excess of water according to Flinn Suggested Disposal Method #26b. The chemicals may form a potentially *explosive* compound, silver fulminate, on standing. Excess silver nitrate solution may be disposed of according to Flinn Suggested Disposal Method #11. Excess sodium hydroxide solution may be disposed of according to Flinn Suggested Disposal Method #10. Excess ammonium nitrate and dextrose solutions may be disposed of 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 Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter
Content Standard F: Science in Personal and Social Perspectives
Content Standard G: History and Nature of Science, historical perspectives

Tips

- Rinsing the tube with acetone before carrying out the silver mirror reaction improves the quality of the mirror. Allow the tube to air dry thoroughly before proceeding.
- Students can make several of the mirrored tubes and glue small corks in them to make holiday ornaments (use paper clips as ornament hooks).
- The silver lining on the inside of the test tubes may be protected from oxidation and mechanical stress by coating the inside of the tubes with clear shellac or clear nail polish.
- If you are using old test tubes, rinse them first with distilled water. Wearing proper hand and eye protection, rinse the tubes again with approximately 2 mL of 6 *M* nitric acid. Rinse a third time with distilled water. Rinse the tubes with acetone, and then again with distilled water.

Discussion

Mirrors, also known as looking glasses, have been known since ancient times. The earliest mirrors were made by polishing disks of a metal such as bronze. These simple mirrors did not last very long due to oxidation of the metal and abrasion from everyday use. In the middle ages, beautiful mirrors were made by backing glass with thin sheets of metal foil, usually silver. Mirrors produced in this manner were very expensive. In 1835, the German chemist Justus von Liebig (1803–1873) invented the silvering process used in this demonstration. This process, which is still used today in the manufacture of household mirrors, involves a variation of Tollens' test. Most household mirrors are made with silver because light reflected from a silvered mirror has a slight pink tinge to it, which enhances skin tones.

Tollens' test is a qualitative test used by chemists to determine if an aldehyde functional group is present in a compound. Treatment of an aldehyde with a solution of silver nitrate in ammoniacal sodium hydroxide produces a silver mirror on a glass surface. This process does not require any electricity and is called "electroless plating." In this experiment, silver metal is produced. Dextrose, a reducing sugar, is used to reduce silver ions in Tollens' reagent to silver metal, which is then deposited on the inside of the test tube. The reactions involved in this activity are summarized below. The structure of dextrose is shown in on page 3.

Reactions

Formation of Tollens' reagent:

$$2AgNO_3 + 2NaOH \rightarrow Ag_2O + H_2O + 2NaNO_3$$

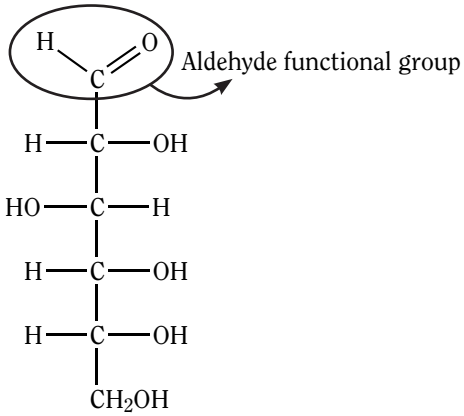
$$Ag_2O + 4NH_3 + H_2O \rightarrow 2Ag(NH_3)_2OH \text{ [Tollens' reagent]}$$

Reduction of Tollens' reagent:

$$R\text{–}CHO + 2Ag(NH_3)_2OH \rightarrow R\text{–}COO^-NH_4^+ + 2Ag + 3NH_3 + H_2O$$

(Aldehyde) (Silver mirror)

Structure of dextrose



References

Ehrenkranz, D., Mauch, J. J. *Chemistry in Microscale*, *Book I*, Kendall/Hunt, Dubuque, IA, 1990

Shakhashiri, B., *Chemical Demonstrations*, *Volume 4*, University of Wisconsin: Madison, WI, 1992; Vol. 4

Materials for *Heigh Ho Silver* are available from Flinn Scientific, Inc.

Catalog No.	Description
D0002	Dextrose, Anhydrous, 500 g
S0026	Silver Nitrate, 100 g
A0241	Ammonium Nitrate, 100 g
S0074	Sodium Hydroxide, 100 g
GP6060	Culture Tubes, 6 × 50 mm

Consult the Flinn Scientific website for current prices.