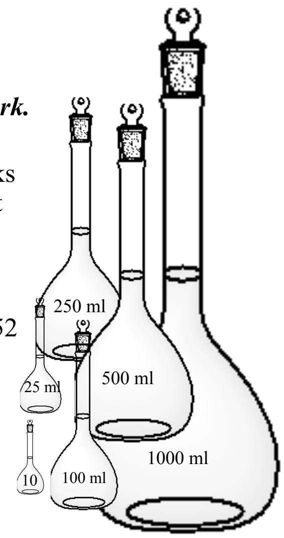
 Silver Mirror Name______________________Per____

Introduction

This lad will demonstrate several different reactions that will produce a souvenir silver bottle. Mirrors, also known as looking glasses, have been known since ancient times. The earliest mirrors were made by polishing disks of a meal 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. 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. This process, which is still used today in the manufacture of household mirrors, involves a variation of Tollen's test for *aldehydes*. Tollen's test is a qualitative test used by chemists to determine whether a *carbonyl* functional group is part of an aldehyde or *ketone*. Treatment of an aldehyde with a solution of silver nitrate in an ammoniacal sodium hydroxide solution produces a silver mirror on a glass surface. This process does not require any electricity and is called "electro-less plating." 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 glass bottle.

PreLAD:

After reading through the procedure, answer the following questions in the space below. Show your work.

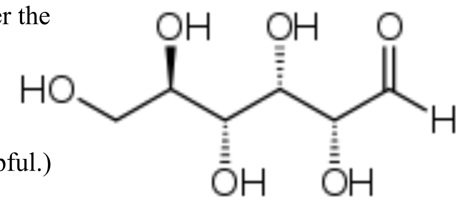


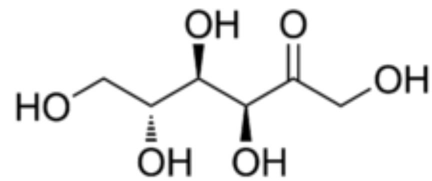
1. Part of being competent in a lab is knowing how to properly make up solutions of particular concentrations. *Volumetric flasks* are used to make solutions of accurate molarity, yet volumetric flasks only come in particular sizes (10, 25, 50, 100, 250, 500, and 1000 ml) Read the procedure to see what volume of each of the three diluted solutions (silver nitrate, potassium hydroxide, and dextrose) is required for a 30 ml bottle to be silvered.
   a. As if you were my lab TA, write out the chemical formula for each of the three compounds, determine the total volume of each of the three solutions you would need to make if each of my 52 students were each going to silver 30 ml bottles, and decide which volumetric flask would be appropriate to use. Keep in mind that you should make more rather than less, and that it is most convenient to only make up one flask of each solution.

   b. Calculate the mass of each chemical required to make those solutions.

   c. Write a very brief bulleted list of how you would prepare the dextrose solution.

2. The chain structure of dextrose, a simple sugar, is shown to the right. Write over the structure, filling in C's for carbon and any H's that are not shown in the structure, but must be present to complete any carbon octets. What is the chemical formula for dextrose? Circle the *aldehyde* functional group on the structure.
   (You may find pg 1002 in your text OR **http://bit.ly/glustructure** this link helpful.)





3. Fructose is also a simple sugar, yet it is a *ketone*. Use your textbook (pg 1002−1005) to distinguish between an *aldehyde* and a *ketone*. Explain the structural difference between the two.

4. The −OH functional group, known as an *alcohol* group, is also referred to as what? What is the *empirical formula* of both of these sugars? In spite of having alcohol functional groups, organic compounds with this empirical formula are referred to as carbohydrates, not alcohols.

Materials at each lab station for two groups to use

- 0.10 M silver nitrate with dropper (white label)
- 0.80 M potassium hydroxide solution (blue label)
- 0.25 M dextrose solution (yellow label)
- concentrated ammonia solution (green label)
- 3 × 10 ml graduated cylinders (labeled white, blue, yellow)

Procedure - ***Eye ware is a must. While it is not dangerous to get silver nitrate on your hands, it will stain both hands and clothes. Aprons and gloves are available.***

A. Measure 6 ml of silver nitrate (appropriate for a 30 ml test tube) from the brown bottle into the appropriately labeled graduated cylinder and pour into your bottle. Screw on the cover and shake to rinse the entire inside surface.

B. ***ALERT − Learn to put drops in so that they fall all the way down into the solution and NOT on the side of the tube.***
Add a drop or two concentrated ammonia swirling and looking for a color change and formation of a precipitate.
ALERT − Learn how to properly flick a test tube to create a vortex and properly mix substances.
Continue to add another drop of concentrated ammonia while swirling, until the precipitate disappears and the solution becomes colorless again. At this moment, STOP adding the concentrated ammonia.

C. Measure 3 ml of potassium hydroxide into the appropriate 10 ml cylinder, then pour into your bottle. Swirl to mix. It is possible that a dark colored solution and precipitate may return. If it does, add concentrated ammonia drop by drop to your test tube, while swirling, until the solution becomes colorless again.

D. Measure 2 ml of dextrose solution into the appropriately labeled graduated cylinder and pour into your bottle. Screw on the cover and swirl and shake for 3 to 5 minutes. At first the bottle will appear to darken, and then will slowly begin to become silver coated.

E. Once the interior is throughly plated, pour the contents of the bottle down the drain with LOTS of water from the faucet. Rinse the interior of the bottle with lots of tap water and pour down the sink. Shake to dry. If you want to really preserve your silver mirror, leave the test tube open to dry for a few days, then put in a small amount of nail polish or paint, tip and swirl to coat the inside, pouring out the excess paint, then leave cover off to dry for a few days. Then recap and display in a safe place.

Disposal and Clean Up

- Leave the tray neatly arranged for the next class. Be sure your hands are washed before leaving the laboratory.

Post LAD Questions

1. Consider procedure B,
   a. the concentrated ammonia solution provides hydroxide ions. Ammonia is NH_3, where do the OH^- ions come from? Write an equation to represent the reaction that produces the OH^- ions.

   b. the hydroxide ions provided by the concentrated ammonia solution in combination with the silver ions from the silver nitrate solution produce a brown precipitate (silver oxide) and water. Write a balanced net ionic equation to represent this reaction.

   c. as excess aqueous concentrated ammonia is added, the silver oxide precipitate dissolves and an aqueous complex ion will form along with free hydroxide ions. Write a balanced net ionic equation represent this reaction. (You will need to include water as a reactant.)

   d. What is the name of this complex ion that has formed? (Refer back to your Conquering Net Ionic Equation Notes – Check out the complex ion section.)

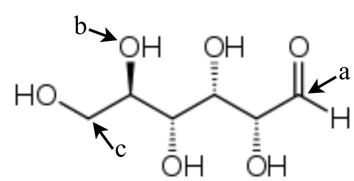
2. In procedure G, the addition of the dextrose causes a redox reaction that is shown below. The dextrose molecule is simplified by representing the important functional group and the remainder of the sugar is represented by the "R" group. (Assume the oxidation states of the atoms within the "R" group add to 0, neutral.)

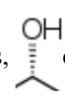
$$R{-}C(H){=}O \; + \; 2\,[Ag(NH_3)_2]^+ \; + \; 2OH^- \; \rightarrow \; R{-}C(OH){=}O \; + \; 2\,Ag \; + \; 4\,NH_3 \; + \; H_2O$$

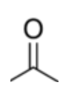
   a. Write the oxidation states above the element that are oxidized and the element that is reduced. State which element is oxidized and which is reduced.

   b. The organic reactant, dextrose, is a sugar. What type of compound is the organic product? (Text pg 1002 will help.)

3. Consider the structure of fructose again,



   a. name the molecular geometry around the carbon labeled (a)
   b. name the electron domain geometry around the oxygen labeled (b)
   c. name the molecular geometry around the carbon labeled (c)
   d. what is the meaning of the bold bonds,  compared to the dashed bonds,  compared to the plain line bonds?

   e. in the structure, what is not showing on the oxygen? 

   f. is fructose likely to be a polar or nonpolar molecule? Justify.