



SPECTROPHOTOMETRIC DETERMINATION OF THE THICKNESS OF COPPER ON A NEW PENNY

INTRODUCTION

Beginning in 1982, minted pennies were made of zinc, with a thin shell of copper on the surface. Before this the pennies were solid copper. In this experiment, you will prepare a standard copper solution and a series of dilutions. From the absorbances of these solutions, a calibration graph will be constructed. The copper on a penny will be brought into solution by reacting the penny with nitric acid. From the copper content of the resulting solution, the amount of copper in the penny may be determined. Using basic geometry, the thickness of the copper shell on the coin will be found.

PURPOSE

The purpose of this experiment is to determine the thickness of the copper layer on post 1982 pennies.

EQUIPMENT/MATERIALS

copper (II) nitrate	100 mL volumetric flasks
pipet	ammonia solution (Concentrated)
Spec 20	cuvettes
calipers	balance
graduated cylinder	nitric acid (1:1 HNO ₃ / H ₂ O)
250 mL volumetric flask	distilled water

SAFETY

- An apron and goggles should always be worn in the lab.
- The copper - nitric acid reaction must be carried out in the fume hood.

PROCEDURE:

PART I: STANDARD SOLUTION

1. A solution containing 10.0 mg per mL of copper is made by dissolving 3.802 grams of $\text{Cu}(\text{NO}_3)_2 \cdot 2 \text{H}_2\text{O}$ in a 100 mL volumetric flask. Add enough water to form 100 mL of solution. Cap and invert the flask several times to ensure that the solution is uniform.
2. 2.00, 4.00, 6.00, 8.00, and 10.00 mL portions of the copper standard are added to 100 mL volumetric flasks. Use a pipet or a buret to measure these samples. To intensify the color of the copper solution, 20 mL of concentrated ammonia solution is added to each volumetric. The solutions are brought up to the volume by adding distilled water to the line. Cap and invert the solutions several times.
3. Warm up a Spec 20. Set the wavelength to 620 nm. This wavelength is in the red region of visible light and is strongly absorbed by the blue copper ammonia complex.
4. Measure and record the absorbance of each solution and prepare a calibration graph.

PART II: PENNY SOLUTION

1. Select a penny and record its mass.
2. Measure the thickness and diameter of the penny using a metric ruler or a pair of calipers (preferred). The measurements should be taken to the nearest 0.1 mm.
3. In the fume hood, place the penny in 20 mL of nitric acid solution (1 : 1 nitric acid & water).
4. Observe the reaction. When the reaction is complete, carefully transfer the contents of the beaker to a 250 mL volumetric flask. Rinse the beaker with distilled water, and transfer the washings to the volumetric flask. Add 20 mL of concentrated ammonia

solution to the volumetric flask. Add distilled water until the solution is brought up to the line. The white product that temporarily forms is zinc hydroxide.

5. Measure the absorbance of the penny solution.

DATA:

PART I: STANDARD SOLUTION

Solution	Concentration	Absorbance
1		
2		
3		
4		
5		

PART II: PENNY SOLUTION

Mass of Penny _____

Thickness of Penny _____

Diameter of Penny _____

Absorbance of Penny Solution _____

CALCULATIONS:

1. Find the concentration of copper in the penny solution from its absorbance. From the concentration and the volume of the solution, determine the mass of copper in the penny.

2. Calculate the surface area of the penny.

a. Calculate the area of the faces.

- b. Calculate the area of the edge of the penny.

- c. Add the values from a & b to get the total area of the penny.

3. Calculate the volume of the copper in the penny. The density of copper is 8.92 grams/cm³.

4. Calculate the thickness of the copper layer using the volume of copper and the surface area.

5. Calculate the percentage of copper in the coin.

QUESTION:

1. Write the equations for the reactions of copper with the nitric acid and the reaction of copper with the ammonia solution.

2. Why was ammonia solution added?

3. What is the name of the ammonia complex that was formed?

4. Why was a wavelength of 620 nm used to analyze the blue solution?

5. Outline another method that might be used to determine the thickness of copper on a penny.