

Determining the Density and Composition of Pennies

Statement of Purpose

To determine the density and the composition of pre-1982 and post-1982 US pennies. The composition of the penny is mostly copper before 1982 and mostly zinc after 1982.

Experimental Planning

We found two ways to determine the density of pennies. Method 1 is to measure the mass of a penny and then determine its volume by measuring its thickness, t , and diameter, d , where $\text{volume} = t \times \pi \times (d/2)^2$. Method 2 is to measure the mass of a penny and then determine its volume by the volume of water it displaces. We've decided to use Method 2 because it seems simpler. To ensure that the change in volume is easier to measure, we will use samples of five pennies each.

To determine the composition of a penny from its density, we will use the following equation

$$d_{\text{penny}} = d_{\text{Cu}} \times x + d_{\text{Zn}} \times (1 - x)$$

where the density of copper, d_{Cu} is 8.96 g/mL, the density of zinc, d_{Zn} is 7.14 g/mL, and x and $1 - x$ are the fractions of copper and zinc in the penny.

Equipment and Reagents

Pennies are taken from a large supply of pre-1982 and post-1982 pennies. A three-digit balance was used to measure mass and a 50-mL graduated cylinder used to measure volumes.

Procedure

Six samples each of five pennies were obtained from the supply of pre-1982 and post-1982 pennies. We confirmed that each penny had an appropriate date, but did not record the individual dates.

To determine the density of pre-1982 pennies, we added approximately 25 mL of water to a 50-mL graduated cylinder. We next placed the cylinder on a balance and tared the balance. We then added five pennies to the graduated cylinder, recording the mass and the volume, repeating this process for six trials.

We repeated this procedure for the six samples of post-1982 pennies.

Experimental Data

Our data is stored in the file pennydata.csv.

The initial volume for the pre-1982 pennies was 25.4 mL, and the initial volume for the post-1982 pennies was 24.9 mL.

Analysis of Data