Name _____   Period _____   Date_____

Use Density to Date A Coin

A penny that has had its date scratched off is found at a crime scene. The year the coin was minted is important to the case. A forensics technician claims she can determine if the coin was minted before 1982 without altering the coin in any way. Knowing that pennies minted from 1962 to 1982 are 95% copper and 5% zinc, whereas those minted after 1982 are 97.5% zinc and 2.5% copper, hypothesize about what the technician will do.

Problem
How can you use density to determine whether a penny was minted before 1982?

Objectives
- **Predict** whether the pre-1982 or the post-1982 pennies will have a higher mass and volume
- **Measure** the volume and mass of pennies
- **Draw conclusions** based on your analysis.

Materials
water
100-mL graduated cylinder
small plastic cup
balance
Pre-1982 pennies (25)
Post-1982 pennies (25)

Metric ruler
pencil
graph paper
graphing calculator (optional)

Safety Precautions

- **Always wear safety goggles and a lab apron.**

Pre-Lab

1. Read the entire **CHEMLAB.**

2. Prepare all written materials that you will take into the laboratory. Be sure to include safety precautions and procedure notes.

3. Review the equation for density. What would be the impact on density of increasing mass while keeping volume constant?

4. Increasing the amount of the heavier element in an object would increase the density of the object. Do you expect the pre-1982 pennies or the post-1982 pennies would have the higher density?

5. What was the make-up of pennies before 1962? How would you expect the density of pre-1962 pennies compare to pennies made post-1982? Between 1962 and 1982?

6. Large objects that consist of the same substance cannot be placed in water to determine their volume. Determine a procedure that could be used to calculate the density of such an object.

7. Write the equation to calculate percent error.

Procedure

Measure the mass of the plastic cup. Pour about 50 mL of water into the graduated cylinder and record actual volume. Add 5 pre-1982 pennies to the cup and measure the mass again. Add these 5 pre-1982 pennies to the graduated cylinder and record the volume. Add 5 different pre-1982 pennies to the cup and measure this mass. Add these 5 pre-1982 pennies to the graduated cylinder and record the new volume. Repeat this process until a total of 25 pre-1982 pennies has been used.

When you have completed the procedure for the pre-1982 pennies, you will follow the same procedure for the post-1982 pennies until 25 pennies has been used.

Sample Data Table

The Density of a Penny				
Trial	Mass of Pennies Added (g)	Total Number of Pennies	Total Mass of Pennies (g)	Total Volume of Water Displaced (mL)
1		5		
2		10		
3		15		
4		20		
5		25		

Analyze and Conclude

1. **Calculate** Complete the data table by calculating the total mass and the total volume of water displaced for each trial.
2. **Make and Use Graphs** Graph total mass versus total volume for the pre-1982 and post- 1982 pennies. Plot and label two lines on the graph, one for pre-1982 pennies and one for post-1982 pennies.
3. **Make and Use Graphs** Draw a best-fit line through each set of points. Use two points on each line to calculate the slope.
4. **Infer** Examine the units for the slopes of the lines. Verifying the slopes of the lines give you the density of the pre-1982 pennies and density of the post-1982 pennies.
5. **Apply** Can you determine if a penny was minted before or after 1982 if you know only its mass? Explain how the relationship among volume, mass, and density support using a mass-only identification technique.
6. **Error Analysis** Determine the percent error in the density of each coin.