

ARE ALL PENNIES CREATED EQUAL?

QUESTION: a.) Do all pennies have the same density? b.) Are all methods of measuring density equally accurate and precise?

HYPOTHESIS:

MATERIALS:

- Pennies
- Graduated cylinder
- 250 mL beaker
- ruler
- scale

NOTES:

- Formula for volume of a cylinder:
$$V = (h) \times (\pi r^2) = \text{cm}^3$$
- Volume by displacement
$$V = \text{mL}$$
- All measurements to nearest 0.1
- Formula for density:
$$D = m/V$$
- Find density using **both** volume measurements for **each** cup

DATA/CALCULATIONS:

PROCEDURE I (Ruler):

1. Stack pennies and use ruler to measure height of stack.
2. Use ruler to measure diameter of penny. Divide diameter in $\frac{1}{2}$ to find radius of penny.
3. Plug values from steps 1 & 2 into the formula for volume of a cylinder.
4. Use scale to measure the mass of your pennies.
5. Use values from steps 3 & 4 to calculate the density of a penny.

PROCEDURE II (Displacement):

1. Fill graduated cylinder with roughly 50 mL of water. Record volume to the nearest 0.1 mL.
2. Carefully add stack of pennies to cylinder. Record volume to the nearest 0.1 mL.
3. Subtract initial volume from final volume to calculate the volume of your pennies.
4. Use the values from step 3 & the previous step 4 to calculate the density of a penny.

CONCLUSION:

Use *CEI format* to write a conclusion in complete sentences and paragraph form.

Claim: Statement(s) telling what you proved in this experiment. If a hypothesis is "pre-evidence," then a claim is "post-evidence."

Ex 1: All pennies have the same density.

Ex 2: All methods for **determining** density are equally accurate and precise.

Evidence: Use complete sentences to show how your data and calculations prove your claim.

Interpretation: Use complete sentences to explain whether this experiment was accurate, precise, both, or neither.

An acceptable range for this experiment is +/- 5%. If 5% above or below the accepted values is accurate for this lab, then 10% of the accepted value is the magic number for precision. Calculate 10% of the accepted value. If the difference between the highest and lowest measured value does not exceed this number, then the experiment was precise.

BONUS: Using the accepted values for density of the pennies and the densities of zinc and copper, calculate the percent composition of pre- and post-1982 pennies.

Accepted Values:

Even #'s = Pre-1982 = 8.8 g/mL

Odd #'s = Post-1982 = 7.2 g/mL

$D_{\text{copper}} = 8.92 \text{ g/mL}$

$D_{\text{zinc}} = 7.14 \text{ g/mL}$