

Name _____

Physical Properties of Matter

Background Information: By definition, all matter has the properties of mass and volume.

The **MASS** of an object is a measurement of how much matter it contains.

The **VOLUME** of an object is the amount of space it occupies.

Mass and volume are Size-dependent properties because they depend on the size of the object.

Another physical property, density, does not depend on the size of an object.

DENSITY measures the amount of mass in a given volume. To calculate the density of an object, divide its mass by its volume.

Problem: To compare the physical properties of pennies minted before 1982 with those of pennies minted after 1982.

Question: Is there a difference in the properties of pennies minted before 1982 and after 1982?

Hypothesis:

Materials:

Graphing calculator	15 Pre-1982 pennies	15 Post-1982 pennies
Graduated cylinder	Triple beam balance	Water

Procedure:

1. Make a **data chart** to record the mass, volume and density of your 15 Pre-1982 pennies. When your chart is complete, have your teacher check and initial it.
2. Use the triple beam balance to find the mass of each of your pennies. Record this data in your data chart.
3. Pour 25 mL water into the graduated cylinder. Use water displacement to find the volume of each of your pennies. Record this data.
4. Find the density of each penny with the graphing calculator:
 - a. Turn the calculator ON
 - b. Select 3 - Your calculator screen should look like this: $\psi\rho$

L1	L2	L3	1
████████	-----	-----	
L1()=			

- c. Enter the *mass data* in L1 by entering the mass of each pre-1982 penny. Press β after each number.
- d. Use the arrow key to move over to L2. Enter the *volume data* in L2 by entering the volume of each pre-1982 penny. Press β after each number.
- e. Find the density of the pennies by using the formula: $\text{mass} \div \text{volume}$.
To do this on the calculator:

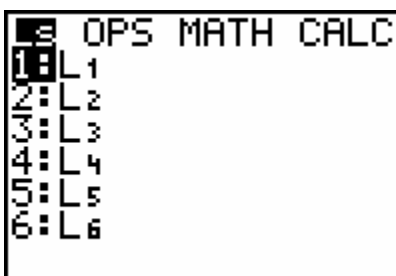
- i. Arrow over to the TOP of L3:

L1	L2	L3	3
1	2	-----	
2	4	-----	
3	6	-----	
4	8	-----	
5	10	-----	
6	12	-----	
L3 =			

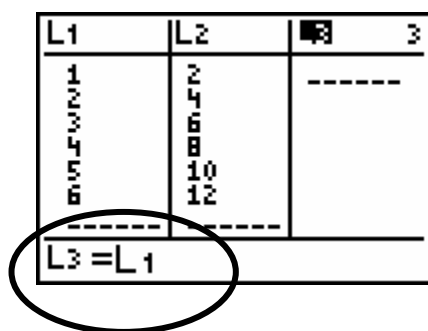
Get your teacher's initials **after** you have entered all of your data and **before** you are ready to find the density:

- ii. The bottom of the calculator screen should read L3 =

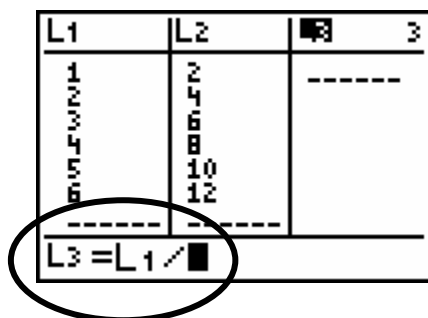
- iii. Press \ominus . Then press Ⓜ (the 3 key.) Your calculator screen will look like this:



- iv. Select L1. Now your calculator screen looks like this:

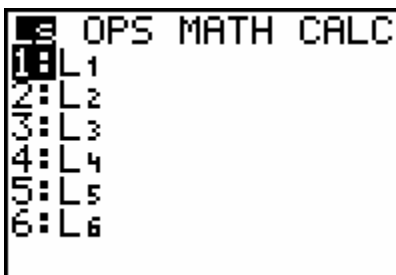


- v. Press Φ . Your screen will show:



Get your teacher's initials
at this step:

- vi. Press \ominus . Then press Ⓜ (the 3 key.) Your calculator screen will look like this again:



vii. Select L2. Now your calculator screen shows:

L1	L2	3
1	2	---
2	4	
3	6	
4	8	
5	10	
6	12	

L3=L1/L2		

This tells us that the calculator will take all the numbers in L1 and divide them by the corresponding numbers in L2.

In this case, mass divided by volume, or DENSITY!

viii. Press β , and the answers to $L1 \div L2$ will be in L3. – This is the DENSITY of each penny.

f. Find the MEAN or AVERAGE density of the pennies:

- Use the arrow key to highlight the top of L3.
- Press \ominus , Press λ (the . key.)
- Press $:$ to clear the screen.
- Press \ominus . Then press ω (the 3 key.)
- Use the arrow key to select MATH:

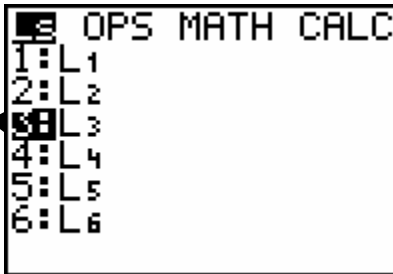
Ls	OPS	MATH	CALC
1:	min(
2:	max(
3:	mean(
4:	median(
5:	mode(
6:	stdDev(
7:	sum(

Get your teacher's initials at this step:

vi. Select 3:mean(:

mean(

- vii. Press \ominus . Then press ω (the 3 key.)
- viii. Select L3:



- ix. Your calculator screen should look like this:



Get your teacher's initials at this step:

- x. Press E (close parenthesis). Press β . The mean (average) of the numbers in L3 will be on the calculator screen.

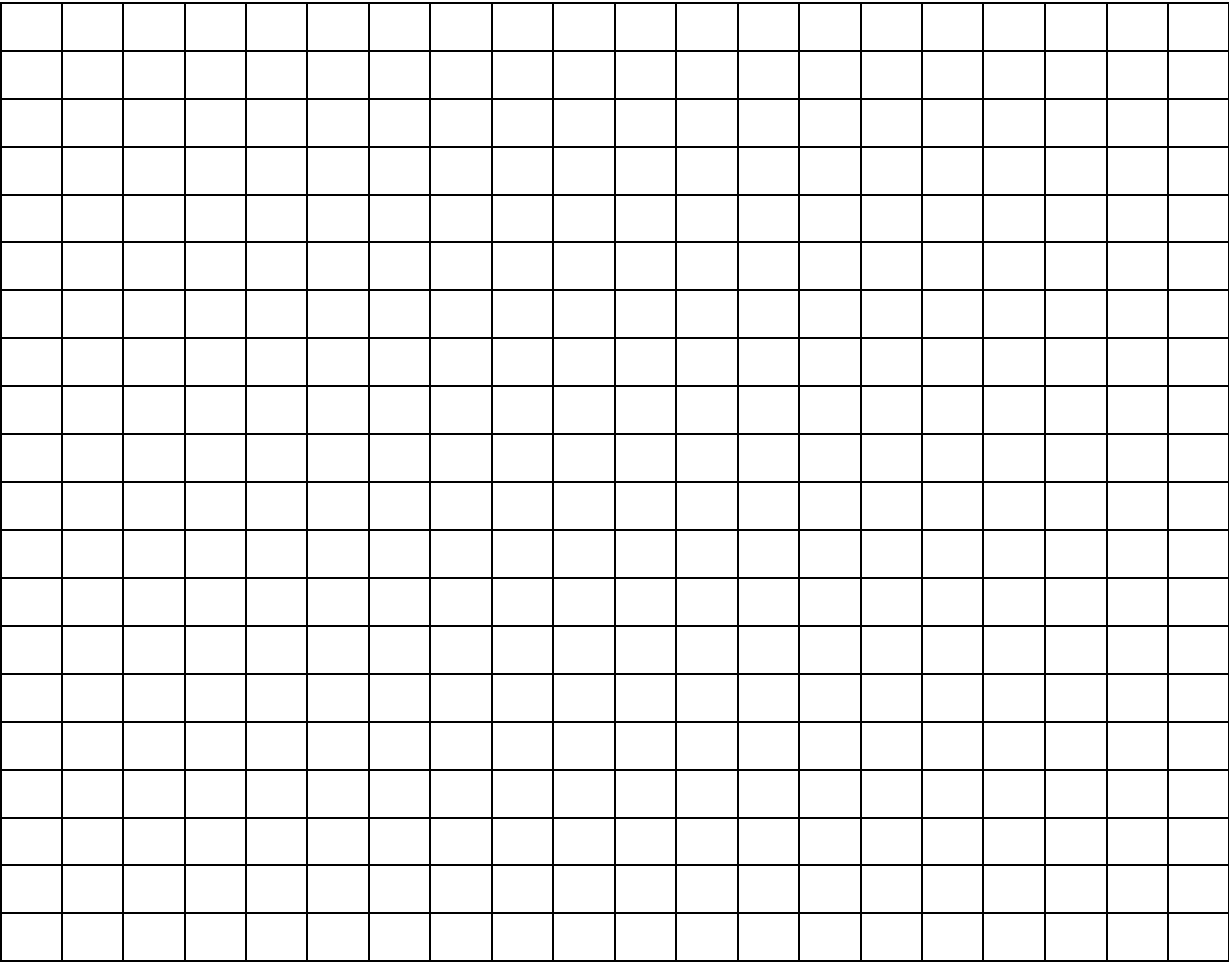
- 5. Record the mean density of the PRE-1982 pennies_____
- 6. Repeat the procedure with the POST-1982 pennies.
- 7. Record the mean density of the POST-1982 pennies_____

Data:

Teacher Initials:

Data Analysis:

Make a BAR GRAPH to compare the data you collected. Remember to TITLE & LABEL the graph.



Conclusions:

What does the data tell you about the density of pennies minted before 1982 and after 1983?

What can you infer from this data?

Questions for Review:

1. Is this investigation descriptive/qualitative or experimental/quantitative? Explain your answer.

2. What is the INDEPENDENT VARIABLE in this investigation?
3. What is the DEPENDENT VARIABLE in this investigation?
4. Why is a BAR GRAPH the best way to display data for this investigation?