



About the Lesson

In this activity, students will measure the mass and volume of several collections of a coin type, enter the data into their handheld and explore for patterns, make a plot and look at the ratio of Mass vs. Volume, create a mathematical model that demonstrates the relationship between mass and volume and discover the density value embedded in the data.

As a result, students will:

- Explore the relationship between the number of coins and their mass, volume and density.

Vocabulary

- mass
- volume
- density
- percent error

Teacher Preparation and Notes

- Students should know how to input data into lists.
- Teachers may want to give more guidance to students regarding the use of the Equation Solver in the Math Menu.

Activity Materials

- Compatible TI Technologies:

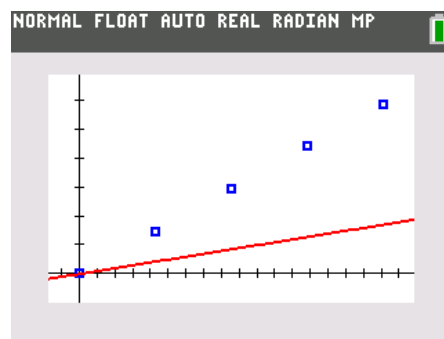
TI-84 Plus*

TI-84 Plus Silver Edition*

 TI-84 Plus C Silver Edition

 TI-84 Plus CE

* with the latest operating system (2.55MP) featuring MathPrint™ functionality.



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Lesson Files:

- Making_Cents_Of_Data_Student.pdf
- Making_Cents_Of_Data_Student.doc



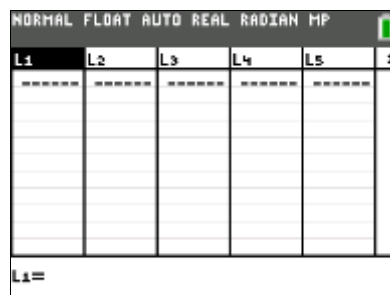
Entering the Data

1. Before entering data in the lists, clear any existing data from the lists.
2. Before entering data in the lists, clear any existing data from the lists. Press $\boxed{2nd}$ $\boxed{[mem]}$. Highlight **4:ClrAllLists**, and then press \boxed{enter} .

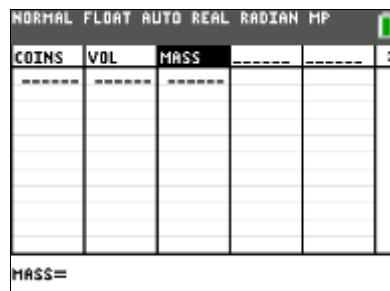
This takes you to the Home screen, and you will see **4:ClrAllLists** with a blinking cursor following it. Press \boxed{enter} , and the TI-84 Plus CE displays *Done*. Your lists are now cleared.



3. Press \boxed{stat} . Press \boxed{enter} to choose **1:Edit**. Make three lists on your TI-84.



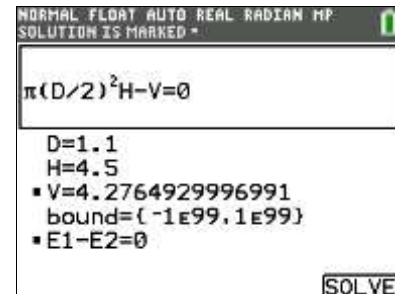
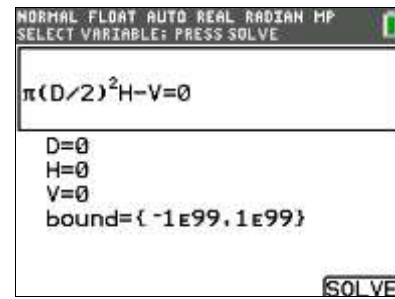
4. Enter your lists COINS, VOL, and MASS. Get into alpha-lock mode by pressing $\boxed{2nd}$ $\boxed{[A-lock]}$, key in the letters for the names. Press \boxed{enter} and then move over to the next column and repeat the process.



5. Measure 7, 14, 21, and 28 coins at a minimum. Move into the list for COINS and enter these numbers. If you have more than 28 coins, keep adding the sets of 7 until you are finished.



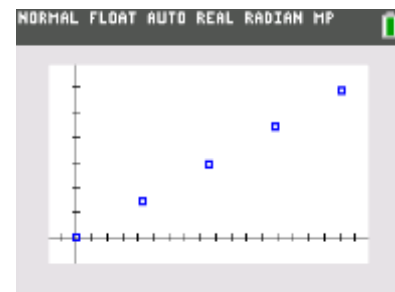
10. Do you see a relationship between the numbers? A pattern? What do you think the mass of one coin is? The volume of one coin? How about 1 dollar?



11. To help determine the pattern in another way we will need to set up a plot. Press **2nd** [stat plot] **enter** and set up the plot as shown. Recall that you can access the list names by pressing **2nd** [list].

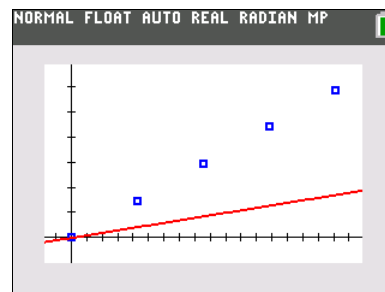
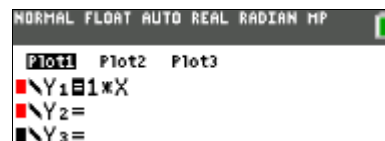


12. Now check to see if you have any equations or plots on. Press **y=** and turn off or clear your equations and see you only have **Plot1** on.
13. Set the Window with **ZoomStat**. Press **zoom** **9** and explore the graph with **trace** **◀▶**.

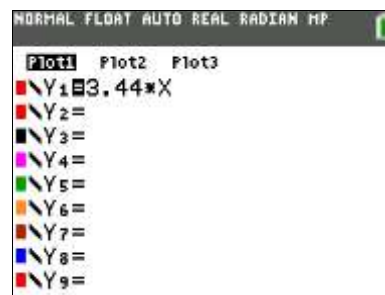




14. We want to guess the equation that fits the data. Press $\boxed{y=}$ and start with $Y1=1*X$. Move to the left of the $Y1$ and press $\boxed{\text{enter}}$ until you get it. Press $\boxed{\text{graph}}$ and see how close you are. If you didn't hit it, keep trying. Recall that $\boxed{2\text{nd}} \boxed{[\text{ins}]}$ to insert rather than overstrike.



15. This number, the one in front of the X, is the slope. The slope is the ratio of the change in Y and the change in X. In this situation that is the change in mass divided by the change in volume, or grams per cubic centimeters. This is the Density!



16. Check on the Internet or with your teacher to get the true density for your coin. The U.S. Mint would be a good place to look. To compare your answer with the actual density we can do a percent error. To get a better value for the density of your coin we can have the computer do the calculation. Return to the List Editor and make a new list named DENSE. Use the techniques used earlier. Press $\boxed{\text{stat}} \boxed{1}$ to get to the lists.

NORMAL FLOAT AUTO REAL RADIAN MP

COINS	VOL	MASS	DENSE	-----	4
7	4.28	14.7	-----		
14	8.55	29.4	-----		
21	12.83	44.1	-----		
28	17.11	58.8	-----		
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DENSE=LMASS/LVOL

17. In the header of this new list we will divide the mass by the volume. The zeros must be removed. To do this move to the place where the zero is and press $\boxed{\text{del}}$ then move to the next one until you have removed all the zeros.
18. Now go to the header of the DENSE list and we will enter the formula MASS/VOL. Get the list names from the list of lists $\boxed{2\text{nd}} \boxed{[\text{list}]}$. Once you have the formula in press $\boxed{\text{enter}}$.

In this case, the solution is $x \leq -4$ or $x \geq 12$.

19. These numbers should vary so we want to get the average. Do you see that these densities are close to the value you used in the $Y=$ area?



20. To get the mean of a list go to the Home Screen and clean up. Press $\boxed{2nd}$ \boxed{quit} \boxed{clear} .

21. To get the command for mean press $\boxed{2nd}$ \boxed{list} $\boxed{4}$ $\boxed{3}$.

```
NORMAL FLOAT AUTO REAL RADIAN HP
NAMES OPS MATH
1:min(
2:max(
3:mean(
4:median(
5:sum(
6:prod(
7:stdDev(
8:variance(
```

22. Now we are ready to do a percent error. The formula is:

$$PercentError = \frac{Truth - Observed}{Truth} \times 100\%$$

Key this in at the Home Screen using the value you picked for $Y=$ as the Observed and the Truth will be what they report is the density of your type of coin. This should be less than 10%. In the sample it is 1.74%!

```
NORMAL FLOAT AUTO REAL RADIAN HP
mean(LDENSE)
3.436754788
((3.5-3.44)/3.45)*100
1.739130435
```