

10-29-2004

Investigating Density

Lorraine Sheck
The College at Brockport

Follow this and additional works at: http://digitalcommons.brockport.edu/cmst_lessonplans

 Part of the [Physical Sciences and Mathematics Commons](#), and the [Science and Mathematics Education Commons](#)

Repository Citation

Sheck, Lorraine, "Investigating Density" (2004). *Lesson Plans*. 249.
http://digitalcommons.brockport.edu/cmst_lessonplans/249

This Lesson Plan is brought to you for free and open access by the CMST Institute at Digital Commons @Brockport. It has been accepted for inclusion in Lesson Plans by an authorized administrator of Digital Commons @Brockport. For more information, please contact kmyers@brockport.edu.

“...a rich **one-page, typed, single-spaced**, description or a *vision* of your best thinking...”

Prompts:

1. How will you assess the prior knowledge of the student?
2. How will you begin the lesson?
3. What are the teacher and students doing every 5-10 minutes? (Teacher Actions and Student Actions)
4. How will you assess the learning for the lesson?
5. How will TI be integrated into your teaching? (i.e. you may want to discuss a problem or describe how you might use the chosen modeling package in your plan. How does the model/tool help the concept(s) to be taught?)

OVERVIEW: *Using the linear regression analysis program on the TI-84 Graphing Calculator*, I plan on having my students investigate a model for determining the densities of several different substances.

Lesson 1

Bellwork (10 min): I would begin the class on modeling density by displaying a 1000 mL graduated cylinder containing four different solids suspended in four different liquids. In a brainstorming session, I would ask students to define density and explain what the solids and liquids in the graduated cylinder are illustrating about density. Their ideas would be written on the chalkboard for later referral.

Desired Outcome: From the positions of the solids and liquids within the graduated cylinder, students should realize that each substance has a characteristic density that can be used to identify it.

Teacher Presentation (Interactive With Students) on Modeling Density (15 min): My presentation would attempt to help students deepen their understanding of density beyond the visual model, to a mathematical model and finally to a graphical model of this concept. *First*, by adding 500mL and 250 mL graduated cylinders to the display with the same liquids and solids as are in the first graduated cylinder, I would attempt to “coax” students, if necessary, to realize that the liquids and solids lay in the same relative position within all three graduated cylinders although the sizes and amounts of each different kind of sample were different. *Secondly*, after having the students find the density formula in their Regents Chemistry Reference Tables, I would explain the equation as representing a mathematical model of density that shows a direct relationship between the mass of a sample and its volume. *Thirdly*, I would select one of the liquids present in the graduated cylinder demonstration (probably water) and write down their masses and volumes on the chalkboard. I would then ask for three student volunteers to write the density formula and use it to calculate the density of each of the water samples. These calculations would remain on the chalkboard for later referral.

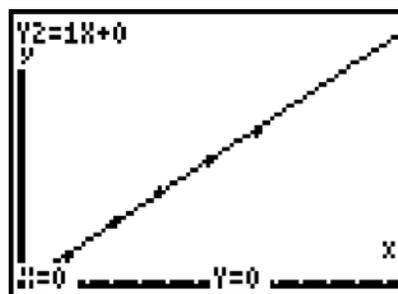
Desired Outcome: Students should realize that based on the equation, the density values for the three samples of water were the same (within experimental error) regardless of how large or small the sample size was.

TI-84 Graphing Calculator Activity (15 min): I would explain that with the help of their graphing calculators, the mass and volume variables of the density equation could be used to develop a graphical model for describing the density of a substance. Students would then be given a table of data listing the masses and volumes of 6 samples of water and charged with the task of graphically displaying the data so as to model the density of water. They would also be provided with a tutorial of detailed instructions for entering lists, setting up and plotting a graph and running and interpreting the linear regression analysis program. Although I would use the TI ViewScreen Panel on the overhead projector to lead them through the calculation, I would also try to pair up students having more calculator experience with students having less experience.

Desired Outcome: By the end of class, students should realize that plotting the mass and volume of the

different samples of water produces a straight line function, the slope of which ($a = 1.000$) represents the density of water. They should also realize that the graphical slope density value is the same as the value calculated from density equation. I would also expect students to display screens similar to those presented below from their TI calculator task.

H2OMS	H2OYL	10
0.000	0.000	
10.000	10.000	
20.000	20.000	
30.000	30.000	
40.000	40.000	
50.000	50.000	
-----	-----	
Name=		



```

LinReg
y=ax+b
a=1.000
b=0.000
r²=1.000
r=1.000

```

Lesson 2

Bellwork (10 min): I would begin the second class by reviewing the previous day's lesson. The graduated cylinder demo would be emphasized as a visual model of density. The equation-based calculations on the chalkboard would be emphasized as the mathematical model of density. I would use the TI ViewScreen to display the linear regression analysis as the graphical model of density.

Unknown Liquid Density Determination Lab Activity (30 min): Working in pairs, students will receive a sample of an unknown liquid. Briefly, students will mass an empty graduated cylinder, fill it with a 10 mL volume of their unknown sample and re-mass the graduated cylinder with the sample. Students would continue to add 10 mL amounts to the graduated cylinder, until 20 mL, 30 mL, 40 mL and 50 mL samples of the unknown were massed.

Desired Outcome: Students will generate a list of mass and volume data values for an unknown liquid that can now be entered in to their TI graphing calculators for linear regression analysis.

Lesson 3

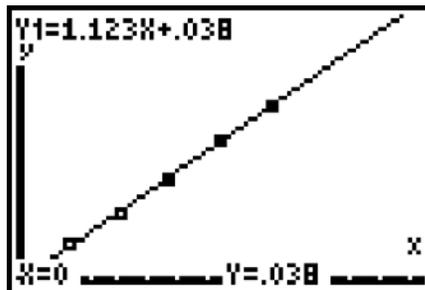
Bellwork (10 min): I would begin the third class by using the TI ViewScreen to review the tutorial on linear regression analysis – how to create lists of data values, how to set up and plot a graph and how to run and interpret the linear regression analysis program.

TI Calculator Activity Using Student Lab Data (15 min): Students will work in groups of three pre-planned so that each student's lab data representing a different unknown liquid. From yesterday's lab activity, students will enter their mass and volume data as lists into the TI, set up and plot a graph and do linear regression analysis to determine the density of their unknown sample. As the students work with their calculators, I will write a table of liquids and their known densities on the chalkboard. When students complete their linear regression analysis, they will be asked to identify their unknown liquid by

comparing their density value with those listed on the chalkboard.

Desired Outcome: In addition to identifying their unknown liquid, students should display their lists, graph and linear regression screens, similar to the ones below.

TMASS	LMASS	LVOLM	9
52.700	0.000	0.000	
65.100	12.400	10.000	
74.400	21.700	20.000	
85.300	32.600	30.000	
98.000	45.300	40.000	
109.40	56.700	50.000	
-----	-----	-----	
LVOLM(?) =			

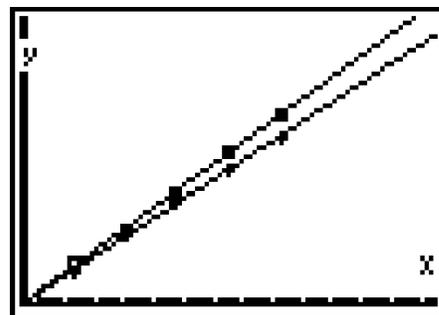


```

LinReg
y=ax+b
a=1.123
b=.038
r²=.998
r=.999
    
```

Concept and Data Analysis Activity (15 min): In this final activity, students will compare TI information from the tutorial water samples with their unknown sample data. The two different “a-values” from the linear regression analyses as well as a view of the two graphical models plotted together (as shown to the left) should make the concept that each different substance has its own characteristic density value more understandable to the students.

Students will then use the 2nd [Table] key to display a table of values for x, y₁ and y₂ (as is shown below). Since the values in the table have been generated based on the linear regression analyses best fit straight line, students can select any x value (representing the volume of the liquid) and find (predict) the corresponding value of y (representing its mass). The x and y values can then be used to calculate the density of the substance.



X	Y ₁	Y ₂
60.000	67.418	60.000
61.000	68.541	61.000
62.000	69.664	62.000
63.000	70.787	63.000
64.000	71.910	64.000
65.000	73.033	65.000
66.000	74.156	66.000
X=65		

EXAMPLE: for x =65.000, y₁ = 73.033

If $D = m/V$, then $73.033/65.000 = 1.124 =$ density value of the unknown liquid.

EXAMPLE: for x=60.000, y₁ = 67.418

If $D = m/V$, then $67.418/60.000 = 1.124 =$ density value of the unknown liquid.

Desired Outcome: Modeling the concept of density with the TI-84 graphing calculator should help students to understand and better conceptualize this physical property of matter. Graphing lines with different slopes illustrates that each different substance has a characteristic density that can be used to identify it. Selecting a specific volume value (x) and its corresponding mass value (y) can be used to predict volumes and masses not actually measured in the experiment. Finally, several of these corresponding x and y values can be substituted into the $D = m/V$ equation to calculate the density of a substance. Since the calculated density values will all be the same for a given substance, students should realize the understanding that each substance has only one density value no matter how large or small the sample size is.

Suggested Rubric: Students will be evaluated with a score from 5 to 0 for each task listed in the table below.

Target	Acceptable			Unacceptable		
	5	4	3	2	1	0
Student participated in graduated cylinder demonstration						
Student was able to use the density equation to calculate density, given a mass and volume						
TI-84 Tutorial -student entered data + displayed lists -student set up + displayed graph -student did + displayed Lin Reg Ana/						
Student gathered reasonable mass + volume data on unknown sample						
TI-84 Analysis of Lab Data (give rating for each step) -student entered data + displayed lists -student set up + displayed graph -student did + displayed Lin Reg Anal -student could explain the scientific significance of the slope of the line from the Lin Reg Anal -student could use TI-84 graphs and tables to predict corresponding mass and volume values not measured						
Student can explain the relationship among the visual, mathematical and graphical models of density						
Student can explain how the TI-84 was helpful in modeling aspects of density						

