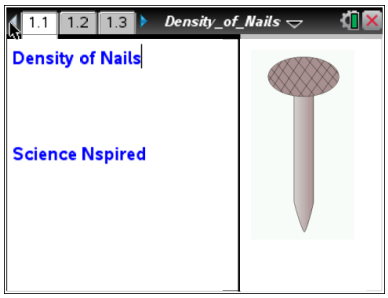
Science Objectives

- Students will determine the relationship between mass, volume, and density.
- Students will understand that objects made of the same material have the same density.



Vocabulary

- mass
- volume
- density

TI-Nspire™ Technology Skills:

- Download a TI-Nspire™ document
- Open a document
- Move between pages
- Entering and graphing data

About the Lesson

- This lesson involves determining the mass and volume of five nails and using the data to calculate density.
- As a result, students will:
  - Determine the relationships, number of objects and total volume, number of objects and total mass, and number of objects and density.
  - Analyze the general trend of a graph as increasing, decreasing, or staying the same.

Tech Tip:

Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Density_of_Nails_Student.pdf
- Density_of_Nails_Student.doc

TI-Nspire document

- Density_of_Nails.tns

TI-Nspire™ Navigator™ System

- Screen Capture to monitor student progress.
- Live presenter allows students to show their graphs to the class.

Activity Materials

- *Density of Nail.tns*
- TI-Nspire handheld
- Five (5) different-sized nails of the same material (7, 8, 9, 10, or 12 penny nails)
- 0.01g balance
- 10 or 50-mL graduated cylinder (depending on the size of the nails)

Discussion Points and Possible Answers

Allow students to read the background information on their student activity sheet.

Move to pages 1.2 – 1.5.

Have students answer questions 1-4 on either the handheld, on the activity sheet, or both.

Q1. The volume of an irregular object is most easily determined by_____.

Answer: D. using water displacement

Q2. Which do you think is heavier?

Answer: C. neither

Q3. Explain your answer to the previous question.

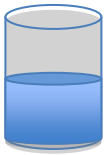
Answer: Neither a pound of feathers nor a pound of lead is heavier because their masses are both equal to one pound. However, the lead has a much greater density since the volume of one pound of lead would be much less than the volume of pound of feathers.

Q4. Density is defined as_____.

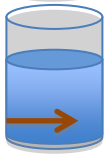
Answer: A. mass per unit volume

In this activity students will be calculating the density of the material used to build nails. They will do this by gathering data for five such nails.

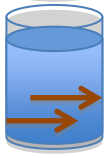
First, they will measure the volume of a container of water, without anything in the water.



Next, they will measure the mass of the first nail then calculate its volume through displacement.



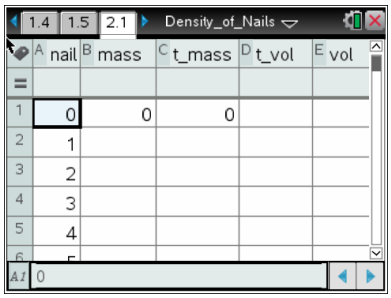
Then students will measure the mass of the next nail and measure the displacement for the combined masses.



Have students continue doing this until they have measurements for all five nails. They will then measure the cumulative data and analyze the resulting graph.

Move to pages 2.1 – 2.2.

Have students answer questions 5 and 6 on either the handheld, on the activity sheet, or both.



Provide the nails to each student or groups of students.

1. Students are to add enough water to the graduated cylinder to cover the tallest nail. Make sure they do NOT add the nails to the water at this time.
2. Students measure the volume of the water to the nearest 0.1 mL and record it in the spreadsheet on Page 2.1 under **t_vol** for 0 nails.
3. Now students measure the mass of the first nail to the nearest 0.01 g and record it under **mass** for 1 nail.
4. As they gently drop one nail, head first, into the cylinder, they measure and record the new volume under **t_vol** for 1 nail.
5. Students need to repeat this procedure for the four remaining nails, accumulating all of the nails in the graduated cylinder.
6. In column C, students calculate the **total mass** (**t_mass**) of the nails. Using cell notation, add each mass to the previous total mass. For example, in cell C2 type **=C1+B2**. Repeat for the four remaining nails.
7. In column E, students calculate the **volume** (**vol**) of each nail. Using cell notation, subtract the previous water volume from the current water volume. For example, in cell E2 type **=D2–D1**. Repeat for the remaining four nails.
8. In column F, they calculate the **density** of the nails. Divide the mass of the nail(s) by its volume. Type **= mass/vol** in the formula bar under **density**.

> **Teacher Note:** Make sure that students understand that in Step 8 they are dividing the mass of one nail divided by its individual volume.

Q5. Record your data and calculations from page 2.1 in the table below.

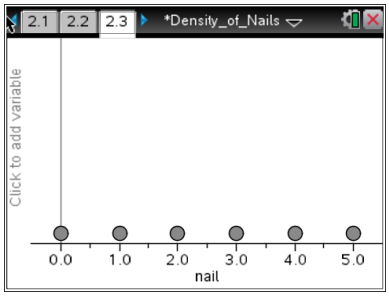
Sample Data:

Column A	Column B	Column C	Column D	Column E	Column F
Number of nails	Mass of Nail (g)	Total mass (g)	Total Volume (mL)	Volume of Each Nail (mL)	Density (g/mL)
0	0	0	***27.0***	**–**	**–**
1	***4.3***	***4.3***	***27.5***	***0.5***	***8.6***
2	***7.06***	***11.36***	***28.5***	***1***	***7.06***
3	***7.73***	***19.09***	***29.5***	***1***	***7.73***
4	***9.64***	***28.73***	***30.8***	***1.3***	***7.42***
5	***15.13***	***43.86***	***32.8***	***2***	***7.57***

Q6. Looking at the column for density, what do you notice?

Answer: The density of each nail is about the same.

Move to page 2.3.



9. Students are to plot the total mass vs. number of nails. On the horizontal axis, they add the variable ***nail*** and on the vertical axis, add the variable ***t_mass***.

Move to pages 3.1 – 3.9.

Have students answer questions 7-15 on the handheld, the activity sheet, or both.

Q7. Plot the total mas vs. number of nails. What do you notice about the graph of the volume of the nails as the number of nails increases?

Answer: It increases.

10. Students now plot the total volume vs. number of nails. Change the variable on the vertical axis to **t_vol**.

Q8. What do you notice about the graph of the mass of the nails as the number of nails increases?

Answer: It increases.

11. Have students now plot the density vs. number of nails. Change the variable on the vertical axis to **density**.

Q9. What do you notice about the graph of the density of the nails as the number of nails increases?

Answer: It is a horizontal line, which means the value stays the same.

12. Last, have the students plot all three graphs, volume, mass, and density by placing the total volume (t_vol) and total mass (t_mass) back on the vertical axis of the graph.

Q10. From looking at the data in the table and the graph, what statement could you make about the density of nails?

Sample Answer: The density of the nails is about the same even though the mass and volume are different.

Q11. If you added another nail to the cylinder of water, which variable(s) would you expect to change and which variable(s) would you expect to stay the same?

Answer: Volume and mass would change, while density would stay the same.

Q12. If you cut a nail in half and added just one of the halves to the cylinder of water which variable(s) would you expect to change and which variable(s) would you expect to stay the same?

Answer: Volume and mass would change, while density would stay the same.

Q13. Suppose you repeated this experiment using marbles, each made of the same material. As you added each marble to the water, how would you expect the density to change?

Answer: B. The density would stay the same.

Q14. Why are the densities you calculated not exactly the same for each nail?

Answer: B. Due to experimental errors in the mass and volume of the nails.

Q15. Summarize what you have learned about density from this experiment.

Sample Answer: The density of objects made of the same material have the same density no matter the mass or volume of the object.

TI-Nspire Navigator Opportunity

Screen Capture can be used to monitor student progress.

Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.