Chemistry

The task

Sample 1 was an entry in a Golden State Examination Science Portfolio for the category "problem solving investigation." Students were required to submit a piece of work and the "Self-Reflection Sheet." In this case, the student designed and conducted an investigation to determine the density of sand. Sample 2 was done in class as a regular lab. The work was done with a partner and written up separately.

Prior Learning

This task requires that students have studied matter and density.

What the work shows

Characteristics of Science

Habits of Mind

SCSh1. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Find answers to scientific problems by substituting numerical values in simple algebraic formulas, and judge whether the answer is reasonable by reviewing the process and checking against typical values.
d. Compare scientific data for two groups by representing their averages and spreads graphically.
e. Decide what degree of precision is adequate, and round off the result of calculator operations to enough significant figures to reasonably reflect those of the inputs.
f. Address the relationship between accuracy and precision and the importance of each.

SCSh5. Students will be able to communicate scientific ideas and activities clearly.

a. Write clear, coherent accounts of scientific activities, including possible analyses and alternative interpretations of the results.
b. Choose appropriate summary statistics to describe group differences, always indicating the spread of the data as well as the data's central tendencies.
c. Make and use tables, charts, graphs, and scale drawings to make scientific arguments and claims in oral and written presentations.

Content

SC1 Students will understand the nature of matter and its classifications.

a. Students will identify and differentiate characteristics of matter in terms of physical (intensive/extensive) and chemical properties.

Chemistry

Sample 1

he Density of Sand

Purpose: To determine the density of a sample of sand with air around the sand granules and then the density of the sand alone.

Procedure:

K

- Find mass of sand + cup — Record
- Find mass of empty cup — Record
- Subtract the mass of the empty cup from the mass of the sand + the cup. The result is the mass of the sand. — Record
- Put sand in a graduated cylinder, note volume. — Record
- Remove sand, put 20 mL water in graduated cylinder.
- Add sand to water, note volume of sand + water — Record
- Subtract the volume of the water (20 mL) from the volume of the water + the sand. The result is the volume of the sand. — Record

Data:

Mass of sand + cup (g)	Mass of cup (g)	Mass of sand (g)
17.30	1.85	15.45

Volume of water + sand(mL)	Volume of water(mL)	Volume of sand (w/o air)mL
26.0	20.0	6.0

Volume of with air: 10.4 mL

Density with air: $\frac{M}{V}$ $\frac{15.45\ g}{10.4\ mL}$ = 1.49 g/mL

Density without air: $\frac{M}{V}$ $\frac{15.45\ g}{6.0\ mL}$ = 2.6 g/mL

Calculations and Analysis:

I

1. This lab was conducted using sand sample A. The mass of the sand was found by finding the mass of the sand in the cup, and then subtracting the mass of the cup. The mass of the sand was 15.45 g. The sand's volume with air, which was found by placing the sand in a graduated cylinder, was 10.4 mL. The sand's volume without air, which was found using the water displacement method, was 6.0 mL.

A

2. The density of the sand with air was found to be 1.49 g/ mL, and the density of the sand alone was 2.6 g/mL. The sand with the air had a lower density than the sand alone. The equation for density is mass divided by volume. For both density calculations, the mass of the sand was the same. However, the volume of the sand with the air was larger than the volume of the sand alone. This is because the grains of sand were separated by air, which made the volume larger than it would be if air was not present. Since the volume of the sand with air was larger, it had a lower density.

D

3. Our answers were compared with those of four other groups.

group #1:	density with air	1.4 g/ mL
	density without air	2.5 g/ mL
group #2	density with air	0.65 g/ mL
	density without air	1.02 g/ mL
group #3	density with air	3.0 g/ mL
	density without air	1.5 g/ mL
group #4	density with air	1.49 g/mL
	density without air	2.73 g/mL

E

4. Three out of the four groups we compared results with had answers very similar to our own. One group, #2, had results that were very different. Since density is an intensive property, the difference in sample sizes among the other groups should not have affected the results. Other groups also may have made errors in their measurements or in their procedures. By double-checking each group's measurements and calculations, it would be possible to determine which group had the most accurate results.

F

5. The procedure utilized in this lab would work well for small, irregular solids such as sand. Many objects, however, would be far too large to place in a graduated cylinder and use the water displacement method. In their instance larger containers could be used. It also would also be much easier to determine the density of regular solids using calculations of length, width, and other dimensions in conjunction mathematical formulas. This method was extremely successful in this example.

A Throughout the work, the student explained the relationship between mass, volume, and density, often with a level of detail revealing excellent conceptual understanding. There is also ample evidence that the student appreciated the relevance of density in everyday situations.

D Here and throughout, the work displays evidence of appropriate scientific thinking and use of experimental data to reach conclusions.

E F The student continually evaluated and critiqued the appropriateness of the experimental design and the accuracy of the measuring process, and described the situations in which the techniques employed would be most effective.

E Comparison of results among groups provided partial confirmation of results.

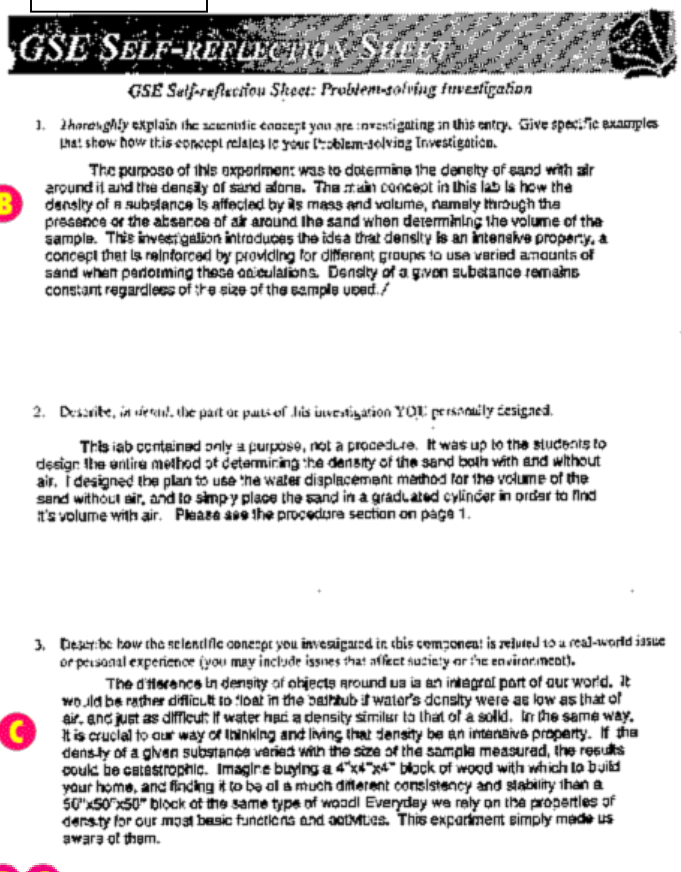
I The student used traditional methods.

E Comparison of results among groups was an effective method for judging accuracy.

New York City Performance Standards

Chemistry

Sample 1



GSE SELF-REFLECTION SHEET

GSE Self-reflection Sheet: Problem-solving Investigation

1. *Thoroughly* explain the scientific concept you are investigating in this entry. Give specific examples that show how this concept relates to your Problem-solving Investigation.

The purpose of this experiment was to determine the density of sand with air around it and the density of sand alone. The main concept in this lab is how the density of a substance is affected by its mass and volume, namely through the presence or the absence of air around the sand when determining the volume of the sample. This investigation introduces the idea that density is an intensive property, a concept that is reinforced by providing for different groups to use varied amounts of sand when performing these calculations. Density of a given substance remains constant regardless of the size of the sample used.

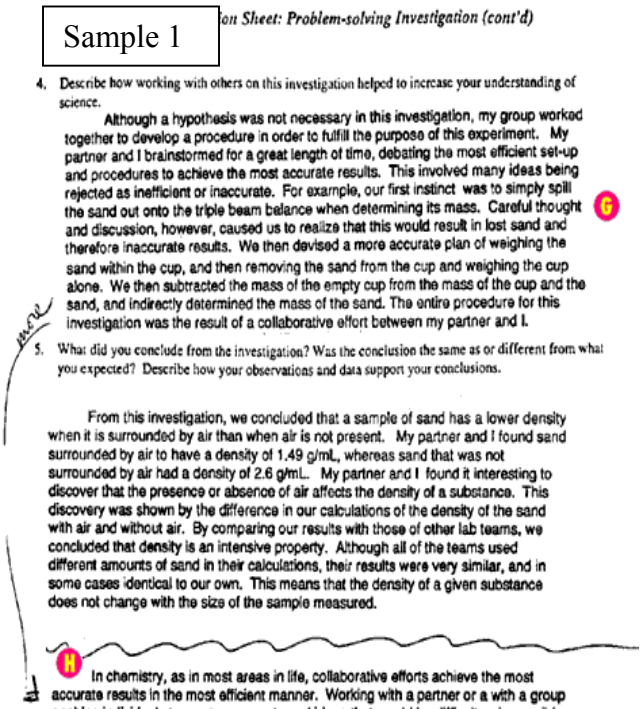
2. Describe, *in detail*, the part or parts of this investigation YOU personally designed.

This lab contained only a purpose, not a procedure. It was up to the students to design the entire method of determining the density of the sand both with and without air. I designed the plan to use the water displacement method for the volume of the sand without air, and to simply place the sand in a graduated cylinder in order to find it's volume with air. Please see the procedure section on page 1.

3. Describe how the scientific concept you investigated in this component is related to a real-world issue or personal experience (you may include issues that affect society or the environment).

The difference in density of objects around us is an integral part of our world. It would be rather difficult to float in the bathtub if water's density were as low as that of air, and just as difficult if water had a density similar to that of a solid. In the same way, it is crucial to our way of thinking and living that density be an intensive property. If the density of a given substance varied with the size of the sample measured, the results could be catastrophic. Imagine buying a 4"x4"x4" block of wood with which to build your home, and finding it to be of a much different consistency and stability than a 50"x50"x50" block of the same type of wood! Everyday we rely on the properties of density for our most basic functions and activities. This experiment simply made us aware of them.

Sample 1



...on Sheet: Problem-solving Investigation (cont'd)

4. Describe how working with others on this investigation helped to increase your understanding of science.

Although a hypothesis was not necessary in this investigation, my group worked together to develop a procedure in order to fulfill the purpose of this experiment. My partner and I brainstormed for a great length of time, debating the most efficient set-up and procedures to achieve the most accurate results. This involved many ideas being rejected as inefficient or inaccurate. For example, our first instinct was to simply spill the sand out onto the triple beam balance when determining its mass. Careful thought and discussion, however, caused us to realize that this would result in lost sand and therefore inaccurate results. We then devised a more accurate plan of weighing the sand within the cup, and then removing the sand from the cup and weighing the cup alone. We then subtracted the mass of the empty cup from the mass of the cup and the sand, and indirectly determined the mass of the sand. The entire procedure for this investigation was the result of a collaborative effort between my partner and I.

5. What did you conclude from the investigation? Was the conclusion the same as or different from what you expected? Describe how your observations and data support your conclusions.

From this investigation, we concluded that a sample of sand has a lower density when it is surrounded by air than when air is not present. My partner and I found sand surrounded by air to have a density of 1.49 g/mL, whereas sand that was not surrounded by air had a density of 2.6 g/mL. My partner and I found it interesting to discover that the presence or absence of air affects the density of a substance. This discovery was shown by the difference in our calculations of the density of the sand with air and without air. By comparing our results with those of other lab teams, we concluded that density is an intensive property. Although all of the teams used different amounts of sand in their calculations, their results were very similar, and in some cases identical to our own. This means that the density of a given substance does not change with the size of the sample measured.

In chemistry, as in most areas in life, collaborative efforts achieve the most accurate results in the most efficient manner. Working with a partner or a with a group enables individuals to master concepts and ideas that would be difficult or impossible for them to understand on their own. While brainstorming ideas for the procedure, my partner and I were able to "bounce" ideas off of one another and receive feedback and new ideas in return. In the same manner, if one partner had overlooked a small detail that might impede the obtaining of accurate results, the second partner was quick to see that potential problem and propose a solution. Through exchanging ideas, critique, questions, and information, my partner and I were able to understand the concepts presented in this investigation.

B C Throughout the work, the student explained the relationship between mass, volume, and density, often with a level of detail revealing excellent conceptual understanding. There is also ample evidence that the student appreciated the relevance of density in everyday situations.

G The student continually evaluated and critiqued the appropriateness of the experimental design and the accuracy of the measuring process, and described the situations in which the techniques employed would be most effective.

H The student has acknowledged the benefits of collaboration.

New York City Performance Standards

Chemistry

Sample 2

hemistry Report

Density of Sand

1. Objective:
In this experiment, my objective is to find the density of sand in the presence of air and without the presence of air.

2. Materials:
To do this experiment, I used: beaker, graduated cylinder, funnel, sand, scale, water.

3. Procedure:
The first thing I did was to take a certain quantity of sand. I poured the sand into a beaker. I weighed the empty beaker before weighing it together with the sand. Then, I poured the same amount of sand (from the beaker) into a graduate cylinder and I measured the volume of the sand.
I recorded the results. Then I divided the weight of the sand into its volume to find its density in the presence of air.
The second thing I did was to pour some water into the graduate cylinder, then I measured the volume of the water. When I finished, I poured the same quantity of sand I had used in the first part of the experiment into the graduate cylinder that contains the water. I stirred them (water and sand) up so that I could get rid of the air in the sand. I measured the volume of the water together with the sand, then I did a subtraction to find the volume of the sand by itself. The result I found was the volume of the sand without the presence of air.
To finish, I divided the weight of the sand by the volume of the sand to find the density of the sand without the air being present.

4. Results:

1) Weight of the graduate cylinder	49.4g
2) Volume of the sand	2ml
3) Weight of the sand	3.2g
4) Weight of the sand and the cylinder	52.6g
5) Density of the sand with air	3.2g/2ml=1.6g/ml
6) Volume of water	5ml
7) Volume of the sand and water	6.2ml
8) Volume of sand	6.2ml–5ml=1.2ml
9) Density of the sand without air	3.2g/1.2ml=2.7g/ml

5. Conclusion:
When I finished with the experiment, I realized that the density of the sand without air is more than the density of the sand with the air. The conclusion I drew is that if you consider the volume of the sand with air and the volume of the sand without air, the sand without air weighs more than the sand with air.

J The student used traditional methods.

Sample 2

DENSITY OF SAND

Work in a group to design an experiment to determine the density of sand with air around the sand granules and then the density of the sand alone. Write a report based on the experiment.

LET US REFLECT ON THE EXPERIMENT

Answer the following questions after completing your report:

1. Describe the scientific concept you have investigated in the experiment.

The scientific concept I investigated was density. I wanted to know if sand without air is heavier than sand with air when they have the same volume.

2. Describe how the scientific concept you have investigated is related to everyday life.

The relationship between this scientific concept and everyday life is that you sometimes need materials that have different densities depending on the type of work you want to do. For example, if you want to make an airplane or a boat, you need a material that is strong but not too heavy.

3. Describe how working in a group helped to increase your understanding of the scientific concept.

Working in a group helped me because whatever mistake I made, another member of the group was able to see it, and together we were able to correct it.

4. What did you conclude from the investigation? Was the conclusion the same as or different from what you expected? Describe how your observations and data support your conclusion.

The conclusion that I drew from this experiment is that when you have 2 types of sand with the same volume, the sand without air will always be heavier than the sand with air. When I say two types of sand, I mean:
1) sand with air
2) sand without air

New York City Performance Standards