They may forget what you said, but they will never forget how you made them feel.

Anonymous
Teacher as a leader ...
- Inspiring the pursuit of improvement and growth
Reflection
Teacher as a leader

There were many rewarding experiences throughout the course of my internship. However, no experience was more rewarding than the one I shared with a student named Jamie (real name omitted for privacy). During the first nine-weeks of the school year, Jamie was one of my lowest achieving students. She consistently arrived late to class, and she was rarely prepared for learning activities. She struggled to answer questions in class, and she never asked questions of her own. Furthermore, she talked out of turn, failed to submit daily assignments, and performed poorly during lab activities. Jamie's grades displayed the negative impact of her weak academic habits. Specifically, her average test score was 59%, and her overall grade was 74%. Her poor performance was found to be consistent across all core content areas.

Unexpectedly, Jamie approached me near the end of the first nine-week grading period. With a worried look on her face, Jamie asked, "Mr. [redacted], why am I so bad at school?" Her question implied that she actually cared about school and that she wanted to perform better. This really surprised me because Jamie's academic habits indicated otherwise. The surprises kept coming as Jamie said, "I really want to do good next nine-weeks. What can I do? Is there someone who can tutor me?" Confused, I asked Jamie why she waited until the end of the first grading period to seek help. She confessed, "I was too embarrassed."

Her reply effectively exposed a major fault of mine. Specifically, I misinterpreted her poor performance and her carefree attitude. I assumed Jamie was a low achieving student with little regard for academics. Sadly, I treated her that way. I rarely asked her questions, and I failed to address her low test scores. I actually began to expect poor work from Jamie. Once I reflected on my fault, I realized my low expectations and my resulting behavior played a major part in limiting Jamie's performance.

With that, I decided to abandon my previous assumptions, and I decided to help Jamie become the student she really wanted to be. I began by offering an apology, which Jamie gladly accepted. Then, I asked her if she would allow me to begin making decisions that would improve her performance. Once again, Jamie gladly accepted. Finally, I told her to put the first nine-weeks behind her. I told her to view the second nine-weeks as an opportunity to start fresh. With a look of relief on her face, Jamie exhaled, "Thank you so much. I am going to do this!" This time, I chose to expect only the best.

Following this challenging conversation, I maintained my high expectations for Jamie, and I made decisions that would help her fulfill these expectations. First, I moved Jamie from the back of the classroom to the front of the classroom. This allowed me to keep a close eye on her academic and social habits. This also removed a number of distractions, which previously restricted Jamie from focusing. Second, I provided Jamie with the opportunity to come to my classroom for tutoring during the final period of the school day. I allowed her to determine when she needed help, but I required her to come with prepared questions. Third, I used social reinforcers and positive feedback to cultivate good academic habits. With a polite smile, I always welcomed Jamie at the door. I gave her more attention by asking her questions and by asking her to help with administrative tasks (ex. passing out papers). Most importantly, I provided Jamie with a light dosing of praise every time she submitted a complete assignment on-time. Concerning positive feedback, I took the time to review every quiz and test with Jamie. In order to show Jamie her level of progress, I began each review by comparing her new scores to her old scores. I then identified her strengths and her weaknesses. During this time, I established that incorrect answers did not indicate failure. Instead, I encouraged Jamie to view them as opportunities to learn and to improve. Finally, during class and during our tutoring sessions, I introduced Jamie to a number of study skills and test taking skills. For example, I taught her how to make her own study guide, and I taught her to begin...
studying at least one week before an exam. I also taught her how to take notes during class and how to include important reminders on her papers. Overall, I provided Jamie with the attention and the support she desperately needed.

Once Jamie’s individual needs were met, she quickly blossomed into a fantastic student. In her classroom notes, Jamie began to highlight important information, and she began to intensely indicate her homework responsibilities (form A). When taking quizzes, Jamie began to use models and other memory devises she acquired during class (form B). After I returned her assignments, Jamie took the time to review them, and she cared enough to make important corrections (form C). She also used a review sheet of mine to create her own comprehensive study guide for a unit exam (form D). The date on her study guide showed that Jamie began to study eight days before the date of the exam. Furthermore, she began to arrive at class on-time, ask her own questions, and consistently submit daily assignments. Jamie’s grades displayed the positive impact of her improved academic habits. Specifically, her first test score was an 84%. This was far above her previous scores of 58%, 56%, and 65%. Her overall grade also rose from a 74% to an 88%. More importantly, her entire attitude towards school and towards herself changed. Instead of being embarrassed and removed, Jamie became confident and involved. She became all that she wanted to be.

Although Jamie discovered her true potential during this experience, I was definitely the one who was most affected. My initial conversation and subsequent experiences with Jamie revealed a few of my own negative assumptions and habits. Specifically, I discovered that I held low expectations for students who performed poorly and for students with behavioral issues. I also discovered that my low expectations greatly influenced the way I interacted with such students. I limited the amount of attention and the amount of responsibility they received. Most importantly, I discovered that my low expectations restricted students from fulfilling their true potentials. This distressed me. I wondered how many of my low achieving students were restricted by my poor performance. This thought encouraged me to change my assumptions and my habits toward low achieving students.

Starting with Jamie, I chose only to entertain high expectations for all of my students. Regardless of their grades or their behavior, I chose to believe only the best for each student. I began every day by meeting them at the door with an inviting smile. I gave them as much individual attention as I could, and I involved them in classroom procedures. I thanked students for answering questions, and I rewarded the class with praise when everyone completed their daily assignments. When students behaved poorly, I reprimanded them, but I never gave up on them. I remained polite, I continued to communicate high expectations, and I kept them involved.

The results were amazing! My lowest achieving students started to voluntarily ask and answer questions in class. They all started to submit their assignments consistently. As a result, I observed their quiz and test scores rise. Apart from this, what affected me the most was the respect they began to show me. They quickly followed my opening instructions and routines. They became silent when I talked. When my students were a little more rambunctious, a few of my low achieving students would take the lead and tell their classmates to quiet down. Lastly, when students did misbehave, they received and followed my correction without question. The entire atmosphere of my classroom changed dramatically!

In fact, the other teachers on my academic team began to notice the change. This was amazing! Veteran teachers wanted to know what I did to positively impact my students. I told them it was as simple as choosing to believe the best about each student, even when they were at their worst moments. However, my advice seemed to fall upon deaf ears. They thought my view was too simplistic. They concluded that our students were bad children in need of serious discipline. My colleagues would not choose to separate the potential of our students from the outward behavior of
our students. For this reason, students began to fulfill low expectations in other classrooms, while they strived for high expectations in mine.

The difference between classrooms allowed me to comprehend the importance of possessing high expectations for all students. I want to become a teacher who always hopes and who always directs their students upward. With the experience above, I know I am one step closer to achieving this goal.

Throughout this experience, I approached my goal by developing my leadership skills. Specifically, I identified the individual needs of Jamie, and I provided learning opportunities to support her development. I used positive social reinforcement and positive feedback to motivate her. I acknowledged her abilities and advocated for her opportunity to succeed. In students as well as in colleagues, I also sought out every opportunity to encourage growth and improvement. Lastly, I openly and honestly reflected on my instructional decisions and their impact on everyone around me. When I discovered decisions that negatively impacted my students, I apologized and strove to make better decisions. Quite simply, I did everything possible to lift and to encourage the people around me. This is the heart of a true leading teacher.
Evidence
&
Lesson plan
Progress report for
Science 8
Ivetti, G.

<table>
<thead>
<tr>
<th>Long Name</th>
<th>Category</th>
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<td>AK</td>
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## Progress Report for [Name Redacted]

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<td>5</td>
<td>100</td>
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<td>100</td>
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<td>100</td>
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<td>0</td>
<td>**</td>
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<td>DP</td>
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<td>5</td>
<td>100</td>
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### Missing Work

<table>
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<tr>
<th>Long Name</th>
<th>Category</th>
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</thead>
<tbody>
<tr>
<td>Test corrected</td>
<td>DP</td>
</tr>
</tbody>
</table>

**Absent Days:** 1  
**Tardy Days:** 1

### Attendance Record

- **Absent:** 11/25/09
- **Early Dismissal:** 10/2/09

For Qtr 2, labs are scored as a group. The group will proofread and check their labs based on in-class discussions, then one student per group will be selected by the teacher to have his or her lab checked. All group members receive the same score, and the person checked rotates with each lab. Labs present 2 columns on the grade sheet. The score is given out of 20 points (AK) and the person checked will receive 1/0 points (DP) while all others receive 0/0.
Lesson 1: Temperature and Density

Expansion: as matter warms up, the molecules become more energetic and take up more space (volume).

Contraction: as matter cools down, the molecules become less energetic and take up less space (volume).

Examples

1. Ball and Ring
   - Ball: expanded when we heated it.
   - Ring: contracted due to cooling.

2. Thermometers
   - A. liquid (water, mercury, alcohol)
     - limited by boiling and freezing
   - B. gas (air)
     - expands too rapidly to be practical

3. Bimetallic Strip (solid)
   - a different metals with different rates of expansion
   - useful in thermostats

Summary

The Real World:

Expansion and contraction due to heating/cooling causes problems for engineers. Look at the examples below and answer each question in terms of expansion or contraction.

1) Why do engineers put up power lines so that they are slack in hot weather?
   - In warm weather, the lines are slack so there is room for contraction in cold weather.

2) What is the purpose of the gap in the road on this bridge?
   - The gap allows the bridge to expand and contract.
Why are the bolts that hold these steel rails together in oval holes? Why are there gaps between adjoining rails?

The oval holes allow the rails to expand/contract and remain line. The rails need space to expand/contract as well.

How much is too much?

This rate of expansion/contraction due to heating/cooling is a characteristic property of matter. Matter will expand or contract at a regular rate due to heating and cooling, so it can be measured and predicted accurately based on the type of matter. How much the material expands is known as the coefficient of expansion.

In solids, this measurement is the coefficient of linear expansion (straight-line).

In liquids and gases, it is known as the coefficient of cubical expansion (all directions). The value is a fractional change in length or volume based on a temperature increase of 1° Celsius. (hint: It's a very small change.)

To calculate how much a particular material will expand/contract due to heating/cooling, use the following formula:

\[
\text{Amount of matter} \times \text{temperature change} \times \text{coefficient of expansion} = \text{change (length or volume)}
\]

Listed below are the coefficients of expansion for selected solids and liquids.

<table>
<thead>
<tr>
<th>SOLIDS</th>
<th>Co. of Linear Exp.</th>
<th>LIQUIDS/GASES</th>
<th>Co. of Cubical Exp.</th>
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<tbody>
<tr>
<td>Glass</td>
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<td>Water</td>
<td>.000021</td>
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<tr>
<td>Platinum</td>
<td>.000009</td>
<td>Mercury</td>
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<td>Hard Rubber</td>
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<tr>
<td>Copper</td>
<td>.000022</td>
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</tr>
</tbody>
</table>

Example:

How much does a 10 m long steel railroad track expand when the temperature changes by 15° C?

\[
\text{amount of steel:} \ 10 \text{ meters} \times \text{temperature change:} \ 15° \text{C} \times \text{Co. of Exp:} \ 0.000013 = \ 60.15 \text{mm}
\]
1) How much expansion will take place in a liter of olive oil when it is heated 70°C?

amount of oil: 1 L

<table>
<thead>
<tr>
<th>temperature change:</th>
<th>Co. of Exp:</th>
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</thead>
<tbody>
<tr>
<td>7°C</td>
<td>0.0001</td>
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</table>

Is it safe to heat it in a sealed 1 liter container? Explain.

No, the volume of 1000.64 mL will be too much for the container, so it will break.

2) How much change will take place when 2 liters of water are heated 50°C?

amount of water: 2 L

<table>
<thead>
<tr>
<th>temperature change:</th>
<th>Co. of Exp:</th>
</tr>
</thead>
<tbody>
<tr>
<td>50°C</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Explain why a full water kettle overflows once it starts to boil.

The volume increases with the increase in heat.

3) In a 50 m length of phone cable suspended between 2 poles, how much will the length increase (sag) between 0°C and 30°C?

amount of copper: 50 m

<table>
<thead>
<tr>
<th>temperature change:</th>
<th>Co. of Exp:</th>
</tr>
</thead>
<tbody>
<tr>
<td>30°C</td>
<td>0.023</td>
</tr>
</tbody>
</table>

What will happen if the technicians place the poles too far apart to account for this?

When the cable contracts, it may snap or cause the poles to bend toward each other due to the tension.

4) How much expansion will occur in a steel bridge spanning 1500 m across the Allegheny River on a day when the temperature rises from 5°C to 25°C?

amount of steel: 1500 m

<table>
<thead>
<tr>
<th>temperature change:</th>
<th>Co. of Exp:</th>
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<tbody>
<tr>
<td>20°C</td>
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How can an engineer account for this daily change in length?

He or she can use expansion joints and shorter lengths.
Read pp. 44-45 in the Properties of Matter lab manual and complete the following chart.

**Temperature and Density: Thermometers**

<table>
<thead>
<tr>
<th>Scale: Fahrenheit</th>
<th>Scale: Celsius</th>
<th>Scale: Kelvin</th>
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<tbody>
<tr>
<td>212°F</td>
<td>100°C</td>
<td>373°</td>
</tr>
<tr>
<td>98.6°F</td>
<td>37°C</td>
<td>310°</td>
</tr>
<tr>
<td>68°F</td>
<td>20°C</td>
<td>293°</td>
</tr>
<tr>
<td>32°F</td>
<td>0°C</td>
<td>273°</td>
</tr>
<tr>
<td>Water boils/condenses</td>
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</table>

*Indicate the temperatures at these locations below for each scale:

- Water boils/condenses
- Human body temp.
- Room temp.
- Water freezes/melts

\[ K = C + 273 \]
\[ C = \frac{5}{9}(F - 32) \]
\[ F = 1.8C + 32 \]

Invented by:
- Fahrenheit
- Anders Celsius
- William Thomson (Lord Kelvin)

Who was one of the first people to attempt to measure temperature? Galileo

What was this man's first device called? Thermoscope

How did this early device work? Used to compare temperatures between different objects.

What was the main problem with the Celsius scale? All temperatures below 0°C became negative numbers.
1. Read pages 48 through 51 in your book and answer the following questions.

a. Use the terms **EXPAND** and **CONTRACT** to explain how a heater can heat an entire room.

   The hot air expands and becomes less dense and so then it rises. Once it reaches the ceiling, it gets pushed aside and more hot air coming up behind it. The hot air goes down and the process goes faster once it gets to the cold window, then...

b. Large birds like hawks can often be seen gliding over big parking lots on hot sunny days without even flapping their wings. Why?

   The sun heats the black top. The black top heats the air that expands and rise this air heat up...

2. Read pages 52 through 55 in your book and answer the following questions.

a. What caused the material in the pipeline to expand and contract?

   The metal that the pipeline is made of changes in temperature.

b. How did engineers overcome this problem?

   They estimated a 20\textdegree C contraction, the pipeline could shrink by as much as 0.3 m. In the coldest weather and expand by an equal amount during the warmest season.

   c. How far does the pipeline expand and contract throughout an entire year?

   \[
   \frac{3.04 \text{m}}{1000} = 3.04 \text{ km segments} \\
   \frac{1500 \text{ km}}{3.04 \text{ km}} = 492.4 \text{ segments} \times 3 \text{ m of expansion} \\
   \text{1480 m of overall expansion}
   \]
1. Closely observe the two cans of Coke. Record any similarities on the left and any differences on the right.

- both a can
- both of the same size
- both have green on them
- both have soda in them and the same amount
- both are made out of aluminum

- different colors
- different ingredients
- orange has residue
- orange has residue on the bottom
- orange has residue
- orange has residue on the bottom

2. What will happen when both cans are submerged underwater in the fish tank? Provide a brief explanation for your prediction.

   One can will float up and the other one will stay underwater.

3. What happened when the cans were submerged and released? Draw a picture of this and provide possible explanations.

   The diet one floated up and the orange stayed on the bottom.

4. Write down the actual explanation.
Density

Density, as it is used in chemistry, is similar to the idea of population density.

Population density = the number of ppl in a defined space

Pittsburgh = 6,000 ppl/mi²
New York City = 26,000 ppl/mi²

Although we are looking at the same amount of space in both cities, New York has more people crammed into that defined space. Therefore, New York City is more densely populated.

In chemistry, density does not relate people and area. Instead, it relates two general characteristics of matter: mass and volume.

Density is defined as the amount of matter within a specific amount of space.

Density = mass per volume

Water = 1 g/cm³
Tungsten = 20 g/cm³

Although we are looking at the same volume, tungsten has more mass crammed into that defined space. Therefore, tungsten is heavier than water.

Density formula
“per” = divided by

Density = \frac{mass}{volume}
Part I. Knowledge

1. The two most important \textbf{general properties} of matter are \textbf{mass} and \textbf{volume}.

2. \textbf{True/False} - The mass of a substance equals the weight of a substance.

3. \textbf{True/False} - Volume is defined as the amount of space that a substance occupies.

4. Density is defined as \textbf{the amount of matter within a specific amount of space}.

5/6. In the space below, draw the density triangle and list the formula for density.

\[
\frac{M}{V} = D
\]

Part II. Understanding

7. Object A has a density of \(2\, \text{g/cm}^3\). If object A is cut into two equal parts, what will be the density of one half? \(\frac{2}{2}\, \text{g/cm}^3\). Of the other half? \(\frac{2}{2}\, \text{g/cm}^3\).

8. Why did the density of object A not change after it was cut into two smaller pieces? Answer below.

\begin{itemize}
  \item A. Density is a general property of matter. Therefore, it remains constant even when the size of object A changes.
  \item B. Density is a characteristic property of matter. Therefore, it remains constant even when the size of object A changes.
  \item C. There must have been an error with the equipment that was used to determine the mass and the volume of object A.
\end{itemize}

9. If you were asked to identify an unknown element, how would you use mass, volume, and density to complete your investigation?

I would find the mass, then the volume, then I would take my answer and round it. If I had to find \(\text{g/cm}^3\), I would look for the density on a density chart to identify the unknown object.

10. Object A and object B are placed in a container of water. Object A sinks to the bottom, while object B floats at the top. What can you conclude about the densities of objects A and B?

\begin{itemize}
  \item A. Object A is denser than object B.
  \item B. The density of object B is smaller than the density of water.
  \item C. All of the above
\end{itemize}
11/12/13. You are given two different liquids, one solid, and their respective densities. You are asked to place these items in a graduated cylinder. Draw the resulting cylinder, the order of the liquid layers, and the location of the solid piece. **MAKE SURE TO LABEL YOUR DIAGRAM!**

Liquid 1 - 2.6g/mL
Liquid 2 - 2.0g/mL
Solid - 2.5g/mL

---

**Part III. Performance**

14. Calculate the density of a material for which a 5mL sample has a mass of 20g.
   a. 5g/mL b. 40g/mL c. 100g/mL d. 10g/mL e. 4g/mL

15. Calculate the volume of a 14.0g sample of material if it had a density of 7.0g/mL.
   a. 28mL b. 3mL c. 2mL d. 12mL e. 35mL

---

**List the station you are using**

What is the volume of water in the graduated cylinder? 39mL 38mL

What is the mass of the metal rod? 17.1 units

18. Assuming the metal rod has a volume of 7cm³, calculate the density of the rod. **SHOW YOUR WORK AND CIRCLE YOUR ANSWER!**

\[
\frac{M}{V} = D \quad \frac{17.1}{7} = 2.4g/cm^3
\]

19/20. List the names of the two pieces of lab equipment at your station.

Equipment A: burner Equipment B: test tube holder
Everything around you is composed of various elements, which are organized on the periodic table. These elements combine with one another in specific ratios. The types and the amounts of the elements within these combinations determine the properties of any piece of matter. These properties are used to describe matter. A few general properties include mass, volume, color, shape, size, texture, odor, and state. Such properties vary greatly. Aside from general properties, there are also characteristic properties. Such physical and chemical properties are unique to a particular substance. Therefore, they are relatively constant and predictable.

Density is an example of a characteristic property. It is basically the ratio of mass and volume. Unlike many observable properties, density is a property of matter that does not change. It is unique to a piece of matter just like DNA or fingerprints are unique to a person. For this reason, density has many important uses. During this lab, you will thoroughly investigate density, its importance, and the role it plays in everyday life.

\[ V = \frac{D \cdot M}{H} \]

**Materials:**
- Triple beam balance/Electronic scale
- Set of seven blocks
- Metric ruler
- 100mL graduated cylinder
- Copper cylinder
- String with loop

**Procedure:**
1. Write a definition for density. Next, write out the formulas for calculating density, mass, and volume. Finally, draw the density triangle.

   - Density: **the amount of matter within a specific amount of space.**

   - Formulas: \[ M = D \cdot V, \quad M = V \cdot D, \quadDV = M \]

2. Complete the following table using procedures and equipment from lab 1.

<table>
<thead>
<tr>
<th>Object</th>
<th>Mass (g)</th>
<th>Volume (cm³)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al block, small</td>
<td>21.2 g</td>
<td>8 cm³</td>
<td>2.65 g/cm³</td>
</tr>
<tr>
<td>Al block, large</td>
<td>143.3 g</td>
<td>50 cm³</td>
<td>2.86 g/cm³</td>
</tr>
<tr>
<td>White plastic, small</td>
<td>1.8 g</td>
<td>10 cm³</td>
<td>0.18 g/cm³</td>
</tr>
<tr>
<td>White plastic, large</td>
<td>48.2 g</td>
<td>20 cm³</td>
<td>2.41 g/cm³</td>
</tr>
<tr>
<td>Clear plastic, small</td>
<td>4.1 g</td>
<td>8 cm³</td>
<td>0.51 g/cm³</td>
</tr>
<tr>
<td>Clear plastic, large</td>
<td>103.5 g</td>
<td>20 cm³</td>
<td>5.17 g/cm³</td>
</tr>
<tr>
<td>Wooden block</td>
<td>10.7 g</td>
<td>15 cm³</td>
<td>0.71 g/cm³</td>
</tr>
<tr>
<td>Copper cylinder</td>
<td>8.1 g</td>
<td></td>
<td>8.9 g/cm³</td>
</tr>
</tbody>
</table>
Conclusions:

1. Below, you will find cubes that represent the materials you worked with during this lab. Write the densities of each material inside their respective cubes.

- Aluminum: 2.65 g/cm³
- Clear plastic: 1.55 g/cm³
- White plastic: 0.94 g/cm³
- Wood: 0.68 g/cm³
- Copper: 8.14 g/cm³

2. Based upon your results, were the densities of the different materials the same or were they different? Did each material have its own unique density? Provide examples.

   Yes, the densities were different. Yes, each one did have their own unique densities, like aluminum was more than two, clear plastic was more than 1, white plastic was almost 1, wood was a little more, and copper was a little.

   Refer to the small and large aluminum blocks when answering the following question: Does a change in the mass or the volume of an object affect its density? How do you know this? Examine the rest of the small and large blocks. Does your conclusion hold true for all of them?

   A change in mass and volume does not affect density. The large and small aluminum blocks have different masses and volumes, but the same densities. This holds true for all materials.

4. Read “Density as a characteristic property” on page 20 and “Mass or weight” on page 21 of your book. Based upon the reading and your answers to questions two and three, what can you conclude about the uniqueness of density? Knowing this, how could density be used to identify the substance from which an object is made?

   Density is a characteristic property that only depends on material and not size.

5. You will find an unknown object at the front of the classroom. Its mass and its volume are listed. Calculate its density and use page 80 in your book to identify the substance. **YOU MUST SHOW YOUR WORK.**
Part 1b: Solids

Materials:
- 1000mL beaker filled with 700mL of water
- Set of seven blocks

Procedure:
One at a time, place each object in the 1000mL beaker. Record whether each object floats or sinks.

<table>
<thead>
<tr>
<th>Object</th>
<th>Density (from part 1a)</th>
<th>Float or sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al block, small</td>
<td>2.71 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Al block, large</td>
<td>2.70 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>White plastic, small</td>
<td>0.70 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>White plastic, large</td>
<td>0.73 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>Clear plastic, small</td>
<td>0.73 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>Clear plastic, large</td>
<td>0.74 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>Wooden block</td>
<td>0.99 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>Copper cylinder</td>
<td>8.97 g/cm³</td>
<td>Sink</td>
</tr>
</tbody>
</table>

Conclusions:

1. The density of water is 1.0 g/cm³. Knowing this, does a relationship exist between the density of an object and its ability to float in water? If so, describe what this relationship is. Provide an example that proves your conclusion.

   There is a relationship between the density of an object and its ability to float. If it sinks or floats, if the density of an object is less than that of water, it will float.

2. One of the most famous people to ever experiment with water and floatation was Archimedes. His experimentation lead to several amazing discoveries. Read about them on pages 22 and 23 in your book and answer the following question: Did Archimedes prove that the crown was made of pure gold?

   Yes, he proved that it wasn't real gold. He put a piece of gold and silver that had the same mass and the silver had a larger volume. The gold was less dense than the gold. Then he put the piece of gold that had the same mass and clipped it in the water and it sank.

3. The Titanic definitely earned its name. It was almost 900 feet in length (3 football fields), and it weighed around 46,000 tons (92,000 lbs)! Read pages 28 through 29 in your book and answer the following questions: What role did density play in allowing this massive ship to float, and what role did density play in allowing this massive ship to sink?

   Air has a density of about one-thousandth that of water. So, the average density of the ship was less than the density of water. It sank because the ship hit an iceberg and the ship filled with water. It sank because the ship was greater than the density of water.
Part 2: Liquids

All liquids are examples of matter. Based upon the definition of matter, all liquids have mass and volume. Therefore, any liquid also has its own specific density, which can be calculated just as it was for solids.

Materials:

- Triple beam balance/Electronic scale
- Three 100mL graduated cylinders
- 250mL beaker with colored water
- Vegetable oil
- Maple syrup
- One plastic screw

Procedure:

1. Write down the steps required for determining the density of a liquid.
   a. put the graduated cylinder on the electric scale
   b. pour in liquid
   c. mass the liquid/graduated cylinder
   d. subtract graduated cylinder mass - gc mass

2. Use the two graduated cylinders and the balance to determine the mass, volume, and density of each liquid. Record your results in the following table:

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Mass of GC (g)</th>
<th>Mass of GC and liquid (g)</th>
<th>Mass of liquid (g)</th>
<th>Vol. of liquid (mL)</th>
<th>Density g/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td>20 g</td>
<td>20 mL</td>
<td>1 g/mL</td>
</tr>
<tr>
<td>Oil</td>
<td>14.3</td>
<td>14.3</td>
<td>14.3</td>
<td>15 mL</td>
<td>0.952 mL</td>
</tr>
<tr>
<td>Syrup</td>
<td>14.4</td>
<td>14.4</td>
<td>14.4</td>
<td>13 mL</td>
<td>-1.145</td>
</tr>
</tbody>
</table>

3. When your chart is complete, tilt the GC with the syrup at a 45-degree angle. Carefully pour the water into the syrup. Then do the same with the oil. Describe what happens to the three liquids, and draw what you observe.

   - The oil forms at the top, the water in the middle, and the syrup at the bottom.

4. Gently drop the plastic screw into the column of liquids. Describe and draw what you observe.

   - It dropped and stopped in the syrup.

Describe - .5

Drawing - .5
Conclusions:

1. Explain why the two liquids stacked in the order they did.
   - [Blank]
   - Incomplete sentence

2. Explain why the screw behaved as it did.
   - [Blank]
   - Incomplete sentence

3. If you added liquid mercury (density of 13.5g/mL) to your current column, then where would it form a layer? Explain why and draw it in the space below.
   - It would form at the bottom because it would be the most dense.

4. If you added a solid piece of lithium (density of 0.5g/cm³) to your current column, then where would it be located in your column? Explain why and draw it in the space below. Remember 1mL equals 1 cm³.
   - Lithium would probably go to the top.
   - It would float at the top. It would be less dense.

5. Oil spills are dangerous events. During an oil spill, thousands of gallons of oil can be released into oceans or coastal waters. The released oil greatly harms seabirds and marine mammals. It also threatens humans by contaminating drinking water, ruining beaches, and making seafood dangerous to ingest. Therefore, it is important to understand how oil behaves in water. From your lab, you know that oil is less dense than water. How can you use this information to devise a cleanup plan for an oil spill?
   - You could clean the oil spill up with water carcose.
   - You could burn the oil on top of the surface area.
Part 3: Gases

Gases do not have definite shapes or volumes. However, they do expand to fill the available space within their containers. Also, because they are examples of matter, gases must have mass. Therefore, any gas also has its own specific density. Although it requires a little extra work, the density of a gas can be calculated.

Demonstrations:

- **Demo 1**

  1. Draw the balloons as they blow up inside bottles A and B.
  2. Why did the balloons behave differently in the two bottles?

- **Demo 2**

  1. Draw the results of water flowing into test tubes A and B.
  2. Why did the water behave differently in the two test tubes?

Materials:

- Triple beam balance/Electronic scale
- Nalgene bottle w/valve stopper
- Vacuum pump
- 100mL graduated cylinder
- 1000mL beaker for wastewater

Procedure:

1. Make sure to wet the seal of the stopper so it provides a better seal on the bottle. Determine the mass of the sealed bottle with the air inside. Record this mass.
2. Use the pump to evacuate as much air as possible. When the seal stays tightly attached to the bottle, you have removed some air. Determine the mass of the sealed bottle without air. Record this mass.
3. Calculate the mass of the air you removed.
4. To determine the volume of the air, fill the bottle with water. Place the stopper on top to account for the volume it displaces. Pour the water into a graduated cylinder multiple times until there is no water left in the bottle. Add up your results to determine the volume of the bottle. Record this volume.

<table>
<thead>
<tr>
<th>Mass of bottle/stopper/air (g)</th>
<th>Mass of bottle/stopper (g)</th>
<th>Mass of air (g)</th>
<th>Vol. of bottle (mL)</th>
<th>Density of air (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110.19</td>
<td>109.59</td>
<td>0.59</td>
<td>650 mL</td>
<td>0.00091</td>
</tr>
</tbody>
</table>
Conclusions:

1. Calculate the density of air. Make sure to show your work and to include units.

\[ \frac{500 \text{ cm}^3 \times 1 \text{ g/cm}^3}{1 \text{ cm}^3} = 0.000983 \text{ units g/cm}^3 \]

2. Balloons filled with helium float effortlessly into the sky when released. Therefore, what can you conclude about the density of helium gas compared to the density of air?

Helium gas is less dense than air
Helium D < air D
-1 We are talking about helium gas not chlorine

3. Read page 34 in your book and answer the following question: Besides the fact that it harmed humans, why was chlorine gas an effective weapon during trench warfare in World War One?

Chlorine gas was an effective weapon during WWI because oxygen is respiration fuel and Carbon dioxide is plant photosynthesis

4. Read pages 35 to 37 in your book and do the following: List two different gases that compose air and explain why they are important to living organisms.

Heated air has a lower density than cooler air

5. Read page 47 in your book and answer the following questions:

a. Why do hot air balloons float?

Hot air balloons float because they have greater temperature differences

b. Why is it easier to fly a hot air balloon when the surrounding air temperature is cooler (like in the morning) rather than warmer (like in the afternoon)?

As air cools, it becomes more dense so it takes less time to rise up.
Properties of matter: Unit test review for Friday, Dec. 18, 2009
50 points – Multiple choices, true/false, and matching

To prepare for the unit test, you should utilize the following review sheet. It outlines the most important topics and ideas we investigated throughout the unit. This information is located in your labs, readings, class notes, and quizzes. Make sure you can explain these topics. Also, make sure you know the definitions of important terms, as well as how to safely perform laboratory techniques.

I. Matter
   a. What is matter?
   b. What is mass? What is volume?
      1. How do we measure mass and volume? What units do we use?
      2. Why are mass and volume general properties?
   c. Use the following: matter outline, matter concept map, lab 1, and quiz 1

II. Characteristic properties of matter
   a. What is a characteristic property?
   b. What are the four characteristic properties of matter that we discussed in class?
   c. Use the following: properties table (created on lined paper in your notebook) and properties of matter concept map

III. Density
   a. What is density, and what are the units for density?
   b. What does the density triangle look like?
   c. What are the formulas for calculating density, mass, and volume?
   d. When measuring mass and volume to determine density:
      1. What equipment do you use?
      2. What procedures do you follow?
      3. What units do you use?
   e. Use the following: density outline, lab 2, density drill worksheet, and quiz 2

IV. Temperature and density
   a. What is expansion?
   b. What is contraction?
   c. How does an increase in temperature affect density, and how does a decrease in temperature affect density?
   d. What is the coefficient of expansion?
   e. How can we calculate the amount of expansion and contraction using the amount of material, the temperature change, and the coefficient of expansion? How do you know what units to include with your answer?
   f. How does a thermometer work, and how do the three temperature scales compare?
   g. Use the following: temperature/density packet and thermometer building packet
V. Phase change
   a. What are the major parts of a Bunsen burner, and what do these parts do?
      1. What are the safety precautions involved with using a Bunsen burner?
      2. What are the steps for lighting a Bunsen burner?
      3. What are the steps for shutting off a Bunsen burner?
   b. What are the three major states of matter, and what are their characteristics?
   c. What is a phase change, and what are the five types of phase changes?
   d. What is necessary for a phase change to occur?
   e. What does the phase change pyramid look like?
   f. What does a phase change diagram look like, and how does it tell you about a material?
   g. Use the following: Bunsen burner safety worksheet, phase change research worksheet,
      lab 3, lab 3 summary notes, readings on pg. 60-63 and 68-70, and quiz 3

IV. Reaction to heat
   a. What can occur when a substance is heated?
   b. Do different substances react differently when they are heated?
   c. How can this be used to identify a substance?
   d. Use the following: lab 4

IV. Lab techniques – You should know and be able to perform the following:
   a. Lab safety procedures
   b. Correct naming and use of lab equipment
   c. Bunsen burner safety and techniques
   d. Find the mass, volume, and density of regular/irregular objects
   e. Interpret tables and graphs (ex. table of densities, table of expansion coefficients, and phase change diagrams)
Friday, December 18, 2009

Jamie

properties of matter, etc.

1. Matter
   a. What is matter?
   anything that has mass and volume
   b. Mass - the amount of matter in an object
   Volume - the amount of space an object takes up
   III. We measure mass using a scale. (grams)
   Volume - graduated cylinder, metric ruler
   2. They change with the amount of matter, and because
   II. a) weight depends on gravity.
   b) Density - mass per volume.
   rate of expansion and contraction, amount of heat required for phase change, and reaction to heating.
   III. a) the amount of matter in a specific amount of space, mass per vol.
   measured in grams per cubic cm. or grams per cubic mm.
a) $\Delta$ the object increases its volume
mass stays the same and density decreases
b) the objects volume decreases, density $\uparrow$
c) move around faster... and expand... contraction — slower get closer
d) $\Delta$ much the object/substance expands

e) matter $\times$ temp. $\times$ coefficient = units will be the same. $\Delta T = 0.5$
what you started with
f) more gases molecules get closer when cold and the liquid goes down opposite for hotter.
g) $^\circ + 273$ to get from Celsius to Kelvin
Matter has...

General properties

- mass
- volume

Characteristics

<table>
<thead>
<tr>
<th>Solid</th>
<th>Liquid</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>compact together</td>
<td>takes the shape</td>
<td>no shape keeps expanding</td>
</tr>
<tr>
<td>temperature stays constant</td>
<td>volume expands</td>
<td>its container changes</td>
</tr>
</tbody>
</table>

IV. a) melting, phase change, chemical change

Every material changes in their own way
c) chemical → changes into another substance  |  phase change → is a physical property

IV. a) I know this
Phase Change:

I. Phase changes depend on temperature and pressure.

II. To change phase, the material must gain or lose energy (heat).

III. The more material present, the more heat it requires to change phases.

IV. Different materials require more or less heat to change phase. Matter changes phase @ dif temps.
Level eight: Labs 1 - 4 and lesson 1 unit test

*** Use the scantron sheet for all of your answers ***

1-10: Multiple choice: Select the letter that best answers the question and fill in the corresponding bubble on the scantron sheet.

1. Matter can be which of the following:
   A. Living  
   B. Non-living  
   C. Visible  
   D. All of the above  

2. What units are included when measuring mass?
   A. Grams (g)  
   B. Cubic centimeters (cm³)  
   C. Pounds (lbs)  
   D. Millimeters (mm)  

3. What is the difference between mass and weight?
   A. Mass measures the pull of gravity. Weight measures amount of matter.  
   B. Mass changes due to gravity but weight is constant.  
   C. Mass is constant while weight changes due to gravity.  
   D. There is no difference between mass and weight.  

4. What piece of lab equipment is used when measuring volume?
   A. Test tube  
   B. Triple beam balance  
   C. Graduated cylinder  
   D. Both B and C  

5. What is the best definition for a characteristic property?
   A. A property that cannot be used to identify a specific substance.  
   B. A property that can be used to identify a specific substance.  
   C. A property that can be observed without changing how a substance looks.  
   D. A property that can only be observed by changing the identity of a substance.  

6. Which of the following is not a characteristic property of matter?
   A. Density  
   B. Mass  
   C. Reaction to heat  
   D. Rate of expansion/contraction  

7. Why is volume not a characteristic property?
   A. Actually, it is a characteristic property. This question is wrong.  
   B. Volume changes with the size.  
   C. Volume cannot be used to identify a substance.  
   D. Both B and C  

8. Object A has a density of 2g/mL. If the object is cut into two equal pieces, then what will be the density of each piece?
   A. 1g/mL  
   B. 2g/mL  
   C. 3g/mL  
   D. 4g/mL  

9. Which of the following statements best explains your answer above?
   A. Density is a general property of matter so it changes with the amount of matter.  
   B. Density is a characteristic property of matter so it changes with the amount of matter.  
   C. Density is a general property of matter so its stays constant regardless of the amount of matter.  
   D. Density is a characteristic property of matter so it stays constant regardless of the amount of matter.  

10. How does the density of 100mL of water compare to the density of 10,000mL of water at the same temperature?
    A. The 10,000mL of water is denser.  
    B. Both volumes of water have the same densities.  
    C. The 100mL of water is denser.  

11-18: Bunsen burner use and safety

Use the large diagram on the right to answer 11 and 12.
11. Which part of the Bunsen burner regulates the flow of gas?
   A. Collar  
   B. Barrel  
   C. Gas inlet  
   D. Needle valve  

12. Which part of the Bunsen burner regulates the flow of oxygen?
   A. Collar  
   B. Barrel  
   C. Gas inlet  
   D. Needle valve

Use the small diagram on the right to answer question 13.
13. Which gas jet is completely on?
   A. Gas jet A  
   B. Gas jet B

14-18. Correctly order the steps (A first and E last) for lighting a Bunsen burner.
   14. Open the needle valve a quarter turn
   15. Tie back hair, put on goggles, and clean work area
   16. Turn on the gas supply
   17. Use the striker to ignite the flame
   18. Rotate the barrel to adjust the flame to an appropriate heat

19-31: Multiple choice: Select the letter that best answers the question and fill in the corresponding bubble on the scantron sheet.

19. You are given an unknown substance, and you are asked to identify it using density. The mass of the substance is 35g, and the volume of the substance is 5cm³. What is the identity of the unknown substance?
   A. 7g/cm³ - Zinc  
   B. 9g/cm³ - Nickle  
   C. 19g/cm³ - Tungsten  
   D. 22g/cm³ - Platinum

20. Object A and object B are dropped into a tank of water. Object A floats, while object B sinks. What can you conclude?
   A. Object B is denser than object A.  
   B. Object A is denser than object B.  
   C. Object A is denser than water  
   D. Object A and B have the same densities.

21. Why do large ships (like the Titanic) float in water?
   A. They are made of steel, and steel is less dense than water.  
   B. They float because they never stop moving.  
   C. They are filled with air. This makes the overall density less than water.  
   D. Nobody really knows why.

22. What happens when a substance is heated and expands?
   A. The temperature increases, volume decreases, mass stays constant, and density remains the same.  
   B. The temperature decreases, volume increases, mass stays constant, and density remains the same.  
   C. The temperature decreases, volume decreases, mass stays constant, and density increases.  
   D. The temperature increases, volume increases, mass stays constant, and density decreases.

23. How much expansion will occur in a steel bridge spanning 1000m across the Allegheny River on a day when the temperature increases from 5°C to 20°C? The coefficient of expansion for steel is .000013.
   A. .065m  
   B. .26m  
   C. 195m  
   D. .39m

24. How would a temperature of 0°C be reported in the Kelvin scale?
   A. -273°K  
   B. 0°K  
   C. 100°K  
   D. 273°K
25. Which phase of matter has molecules that are low in energy and packed tightly together?
   A. Solid  B. Liquid  C. Gas  D. Plasma

26. What happens when a substance gains energy in the form of heat?
   A. The molecules speed up and move closer together.
   B. The molecules speed up and spread apart.
   C. The molecules slow down and move closer together.
   D. The molecules slow down and spread apart.

27. Why does it take water so long to boil?
   A. It needs to absorb enough heat to boil.
   B. Water always starts out at really cold temperatures.
   C. Water does not boil.
   D. Water is just plain stubborn.

28. How can heating a substance help you to identify it?
   A. It allows you to determine its rate of expansion.
   B. It allows you to determine its melting and boiling points.
   C. It allows you to determine how it reacts to heating.
   D. All of the above

29. Which of the following is not a physical property?
   A. Mass
   B. Flammability
   C. Melting and boiling point
   D. Volume

30. A chemical property is different from a physical property because...
   A. A chemical property can be observed without changing the identity of the substance.
   B. A chemical property describes how a substance changes into another substance during a chemical reaction.
   C. A chemical property describes a phase change only.
   D. A chemical property is easily observed.

31. Phase change occurs when...
   A. Heat/energy is added.
   B. Heat/energy is subtracted.
   C. Either A or B occurs.

32-36: Matching: Identify the missing phase changes in the triangle below

Below is a phase change graph of an unknown substance that was heated. Use the graph to answer questions 37 - 42.

37. What is the temperature of the substance at point B?
   A. -60°C  
   B. -70°C  
   C. -80°C  

38. At point B, the substance begins to:
   A. Vaporize  
   B. Melt  
   C. Freeze  

39. What state is the substance in at point C?
   A. Solid  
   B. Liquid  
   C. Gas  

40. How long did it take to completely turn the substance into a gas?
   A. ~14 minutes  
   B. ~16 minutes  
   C. ~18 minutes  

41. Which of these statements best proves that this substance is not water?
   A. The melting point is too low for water.  
   B. The freezing point is too low for water.  
   C. The boiling point is too high for water.  

   D. Actually, the above graph looks exactly like the graph for water. So, the substance is water!  

42. This graph represents a _________ change in the matter.
   A. Physical  
   B. Chemical  
   C. Non-existent  

43-50: True and false: Fill in the letter "A" if a statement is true. Fill in the letter "B" if the statement is false.

43. Mass and volume are characteristic properties of matter.  

44. When measuring the volume of a liquid, you always read the top of the meniscus.  

45. Solid copper will have a greater density than air.  

46. When a substance is heated and expands, its density will decrease.  

47. When heating a test tube over a Bunsen burner, the tube should sit at the top of the inner blue flame.  

48. Different materials require different amounts of heat/energy to change phases.  

49. Difference in boiling point is a useful way to separate different types of liquids when they are mixed together.  

50. The way in which a substance reacts to heating cannot be used to identify it.
Teacher as a ...
- Learning theorist
- Curriculum designer
Reflection
Teacher as a learning theorist and a curriculum designer

The first topic of discussion in the chemistry quarter was matter. It was quite logical to begin with matter because understanding it allowed my students to discuss future topics like density and boiling point. In this portion of the chemistry quarter, my students would discover terminology including mass, volume, and weight. They would also learn how to measure mass and volume using essential laboratory equipment like triple beam balances and graduated cylinders. My students’ success in future lab activities greatly depended on a firm understanding of matter and its two most important general properties. Thus, although the opening topic was relatively simple, it was very important that my students thoroughly comprehended it.

Although the majority of the information in this section would be new, I wanted to challenge my students to express what they already knew. In other words, I wanted to activate their prior knowledge of the subject. Constructivist learning theory asserts that meaningful learning cannot take place unless students have prior knowledge to which they can relate new ideas. If the material being presented fails to overlap with existing knowledge structures, then students may struggle to process and to truly acquire it.

For this reason, I began my first lesson by asking my students to construct their own definitions of matter. The evidence included with this reflection is a perfect example. In this example, Jane (real name omitted) defined matter as, “molecules that create the universe; is everything.” Although her definition was rather broad, it revealed at least a partial understanding of matter. Specifically, Jane believed everything in the universe was made of matter, and she believed matter was made of molecules. Such thinking was absolutely correct. This established a baseline of knowledge to which I could add new factual and procedural knowledge.

During this activity, I noticed that my students were more willing to participate and more excited to learn once they received the opportunity to express their prior knowledge. I did not treat them as if they were empty vessels, containing nothing of worth and unable to offer meaningful insight. Instead, I respected my students by allowing them to provide valuable contributions to the class’ understanding of matter. In doing so, I helped my students discover that the opening topic was not completely new. They realized that we were simply going to expand what we already knew. This seemed to relax my students.

After establishing this baseline, I challenged my students to use their definitions to explain why two objects at the front of the classroom were examples of matter. One of the objects was a wooden block and the other object was a large Styrofoam ball. Jane attempted to use her definition to analyze the two objects. At first, she said the two objects were examples of matter because everything was made of matter. She was correct in saying so. However, when I asked her to identify the two general properties that defined all matter, she was unable to do so. In fact, none of my students were able to accomplish this. Once they realized that their knowledge of matter was rather limited, I informed them that we would use the next few lessons to expand our understandings of matter.

I proceeded with the rest of the matter section by equipping my students with a skeletal outline entitled “What is matter”. This outline focused on the definitions of matter, mass, and volume. It also focused on the three states of matter, as well as their chief characteristics. As I discussed the issues contained in the outline, my students were required to fill in the blanks on their outlines. Constructivist learning theory asserts that students struggle to identify important concepts when they are confronted with large amounts of information. Therefore, constructivists recommend that teachers facilitate learning by directing their students towards important information. One effective technique includes the use of skeletal notes. They draw attention to the
most important information, establish relationships between various concepts, and allow students to remain more attentive during class.

I included a copy of Jane's skeletal outline with this reflection. It shows that she was able to correctly fill in every blank. This proves that Jane was able to pay attention to my presentation, and it proves that she was able to identify the most important information.

Cognitive learning theory establishes that students must pay attention to important information in order to process it and move it from their sensory registers into their working memories. Ultimately, processing the information in their working memories allows students to store it in their long-term memories. Thus, Jane's use of a skeletal outline allowed her to pay attention to the most important information. As she paid attention to this information, Jane moved it into her working memory and began to process it. In doing so, she maximized the probability that she would store the information in her long-term memory. Such processing became evident at the end of class when I asked my students to answer questions related to matter. I asked, "What are the two general properties of matter? How do we define mass? How do we define volume? Which state of matter is easily compressed?" My students, including Jane, were able to quickly and correctly answer these questions without looking at their outlines! Their ability to recall the information proved that they processed and stored it effectively.

I also used visual aids to promote processing and storage. Specifically, I performed demonstrations that visually displayed the characteristics of all three states of matter. For example, I blew up a balloon in order to prove that gases took the shape and the volume of their containers. I also used a plunger system to show my students how gases flowed and were compressed easily. Constructivist learning theory asserts that the use of visual aids allows students to effectively encode and store information in their long-term memories. I observed this first-hand. At the end of the class, when I presented my students with summary questions, I asked Jane to identify the three characteristics of gases. As she thought about the characteristics, I performed the demonstrations described above. When I did, she was able to quickly recall the three characteristics. Her ability to recall the information proved that the visual aids helped her to process and store it.

Still, it was not enough for my students to simply know and recall information related to matter. They had to be able to accurately measure mass and volume. I knew my students could not effectively learn these procedures by listening to a lecture. Furthermore, I would not be able to assess their procedural skills unless they physically performed the skills. For this reason, I decided to create a lab activity during which my students used three different pieces of lab equipment to measure mass and volume.

I began the lab by reviewing the necessary techniques for measuring mass and volume. I modeled these techniques for my students, and I required them to imitate the techniques as I reviewed them. Social cognitive theory establishes that students can learn by simply observing and imitating the behaviors of others. My students observed me, and they imitated the techniques I performed. Thus, according to social cognitive theory, they should have been able to acquire my techniques.

As my students completed all three sections of the lab activity, it became evident that they acquired the skills I modeled for them. They used terminology such as triple beam balance, graduated cylinder, and metric ruler. They carefully and correctly used these pieces of lab equipment to measure mass and volume. What is more, they were able to accurately measure mass and volume. Jane's lab packet confirms this. All of her answers were accurate. They also contained the correct number of decimal places, and they possessed the correct metric units. This would not have been possible if they had not learned the necessary techniques prior to beginning the lab.

After completing and reviewing the lab, I wanted my students to understand how their knowledge of matter expanded. To accomplish this, I decided to have my students create concept
maps. A number of effective learning and study strategies focus on the way information is organized. When information is highly organized in the form of a concept map, students can encode it verbally and visually. This promotes efficient storage of the information within students' long-term memories. It also promotes faster recall. With this in mind, I taught my students how to create concept maps. After doing so, I challenged them to create concept maps that outlined matter and its related concepts.

Jane's concept map is included with this reflection. It is proof of her learning. In the beginning of this section, Jane's definition of matter was simple and broad. Aside from knowing that everything was composed of matter, Jane possessed little knowledge about the underlying details of matter. Her concept map reveals a much deeper comprehension about matter and its related concepts. Specifically, she was able to define matter as anything that had mass and volume. She was able to define both mass and volume. Furthermore, she was able to identify the necessary tools and units for accurately measuring mass and volume. She even included branches that identified the three states of matter and differentiated mass and weight. In the end, Jane clearly acquired an understanding of many new concepts, and she was able to establish relationships between those concepts. The concept map visually confirms this.

Aside from providing evidence of student learning, my lessons on matter provide evidence of my growth in two domains of the leading teacher program. Specifically, I developed as a learning theorist and as a curriculum designer. As a learning theorist, I concerned myself with how students learned best, and I committed myself to appeasing those styles of learning. For example, I learned from constructivist theory that students processed information better when the important concepts were specified. Thus, in order to promote efficient processing, I created a skeletal outline that required my students to write down short amounts of notes for only the most important concepts. I also utilized multiple instructional strategies to encourage all of my learners. Specifically, I utilized lecture, demonstrations, lab activities, and a short PowerPoint presentation to deliver information. I had my students write about, talk about, and draw the various concepts. My instructional approach was in no way one-dimensional. Instead, I supported academic growth by providing multiple avenues for my students to access information and to express their learning.

As a curriculum designer, I used multiple learning theories and educational research to plan my instruction. I considered social cognitive theory, constructivist learning theory, metacognition, and cognitive views of learning as I planned my lessons. I did not simply rely on what I thought was correct, and I did not simply reproduce the techniques of my previous instructors. Instead, I used theory and research to guide me. As a curriculum designer, I also motivated my students by making the content meaningful (accessing prior knowledge) and by using engaging activities (lab), which required students to socially interact. Lastly, I used both formal and informal assessment strategies to continuously monitor the development of my students. Specifically, I used student definitions, outlines, lab packets, and concept maps. I also observed students as they completed their labs, and I listen closely during classroom discussions. Later on, I used a quiz and a test. Just as my instructional approach was in no way on-dimensional, neither was my method of assessment.
Evidence & Lesson plan
Define Matter: molecules that create the universe is everything.
What is matter?

I. All substances are made of matter.
   a. All things and ______ things are made of matter.
   b. Matter can be ______ and ______ to the unaided eye.

II. Matter has two key properties.
   a. All matter has ______.
   b. All matter takes up ______ (has ______).

III. Matter exists in three states.

<table>
<thead>
<tr>
<th><strong>Solid</strong></th>
<th><strong>Liquid</strong></th>
<th><strong>Gas</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed volume and shape</td>
<td>Fixed volume but not shape</td>
<td>Hase volume and space of container</td>
</tr>
<tr>
<td>Not easily compressed</td>
<td>Little free space</td>
<td>Particle move past one another</td>
</tr>
<tr>
<td>Does not flow easily</td>
<td>Flows easily</td>
<td></td>
</tr>
</tbody>
</table>

Ex. Steel and wood | Ex. Water and honey | Ex. oxygen and CO₂

IV. Matter has mass.
   a. Mass is defined as the ______ of matter in a substance.
   b. Unlike ______, mass does not depend on gravity.
   c. Mass can be measured.
      i. Mass is measured in ______ and in ______.
      ii. Mass is measured with a ______ balance and an ______ scale.

V. Matter has volume.
   a. Volume is defined as the ______ of ______ that a substance occupies.
   b. Volume can be measured.
      i. Volume is measured in ______ and in ______.
      ii. Volume can be measured in two different ways.
         1. Regular solid objects are measured with a ______ ruler.
         2. Irregular solids and liquids are measured with a ______.
Everything in the Universe is made up of Matter. Matter occupies a space due to its mass. Therefore, many aspects can be measured: its weight, its volume, and its dimensions: length, width and thickness. These measurements are determined by comparing the object to a standard. A measuring cup for liquids is a standard as is a ruler for dimensions.

In this Lab., you will be using various standards: a Meter Stick and Metric Ruler, a Graduated Cylinder, and a Triple Beam Balance. Each of these standards will measure a various aspect of Matter.

I. Measuring Length in the Metric System:

EQUIPMENT: Metric Ruler, Meter Stick, one sheet of notebook paper, coins: dime, nickel, quarter.

PROCEDURE:

A. Examine a Metric Ruler.
Note that it is divided into units of 10.
Each unit, such as, 1, 2, 3 and 4 represent the number of centimeters. (1/100th of a meter)
The smallest subdivision (unnumbered, between each centimeter) is the millimeter (1/1000th of a meter). The Meter Stick is also divided into groups from 10 to 100. The length from 10 to 20 represents one decimeter (1/10 of a meter).

B. When using a Meter Stick, always place it on its edge due to the thickness, so as to obtain a more accurate reading. Avoid using the extreme left or right ends because they may be ragged from excessive use. Instead use a scale found some place inside of these ends.

C. Use a Metric Ruler to precisely measure the procedures listed below. Place your answers on the accompanying Data Chart.

1. Draw a line 35 mm long. This is the width of photographic film used in a 35 mm Camera.

2. Draw a line 2" long and then measure it to the nearest mm.

3. Measure the length and width of a piece of notebook paper to the nearest cm.

4. Measure the thickness of a $.05, $.10 and $.25.

5. Determine the surface area of the top of your desk.

6. Imagine your desk as a box, determine its volume.

*Remember to include UNITS
II. MEASURING VOLUME IN THE METRIC SYSTEM:

A. The volume of a liquid is measured in cc (cubic centimeters) or ml (milliliters). A Graduated Cylinder is often used to obtain accurate measurements. The surface of the liquid is always curved slightly upward due to the force of ADHESION, the attractive force between different kinds of atoms or molecules. The action of a glue is a prime example of this force. The curved surface is called the MENISCUS. Always take the reading at eye level, reading the bottom of the meniscus as illustrated in the diagram.

1. Using the illustration, determine the volume: \( \boxed{17} \) ml

B. Determine the volume of any irregular shaped object that will fit into a 100 ml Graduate Cylinder by the following:

Equipment: Graduate Cylinder, a piece of string, 3 small objects.

Procedure:

1. Place more than 40 ml. of water (no more than 65 ml.) in the G. Cylinder. Measure its volume. Remember: Read from the MENISCUS.

\[
\text{Volume A} = 49 \text{ ml.}
\]

2. Tie the piece of string to each irregular shaped object and lower each one into the G. Cylinder until it is totally submerged in the water. The water level will rise due to it being displaced by the object. For this reason, this procedure is called DISPLACEMENT.

Measure the new volume for each object:

\[
\begin{align*}
#1: & \quad 33 \text{ ml.} \\
#2: & \quad 31 \text{ ml.} & \text{(Volume B)} \\
#3: & \quad 35 \text{ ml.}
\end{align*}
\]

3. Determine their volume by subtracting the first volume(A) from the second or new volume(B).

\[
B - A =
\begin{align*}
#1: & \quad 23 \text{ ml.} \\
#2: & \quad 11 \text{ ml.} \\
#3: & \quad 5 \text{ ml.}
\end{align*}
\]
III. MEASURING WEIGHT IN THE METRIC SYSTEM:

Weight is the measure of the pull of gravity on an object's mass. The standard for determining weight is a scale. It normally determines the weight of your mass by measuring the pull of gravity on your body as you stand on the scale. The TRIPLE BEAM BALANCE is a scale for measuring the weight of an object in the Metric System. From the diagram, you can easily see why it is called a TRIPLE Beam - three beams for measuring weight. Measurement on a TB Balance compares the unknown weight on the Scale Pan to the known combined weight on the Beams. Gravity is not really a factor since it is the same on both sides of the Balance. You will recognize this as a 1st Class Lever!!

Procedure:

1. The Sliding riders are set at their zero marks. The pointer should be pointing to center of the balance scale. The object to be weighted is placed on the Scale Pan. The pointer is now above the center of the balance scale.

2. Move the rear rider on the beam(100 grms) to the right to a notch where it causes the beam to drop. Then back off to the previous notch.

3. Move the 10 gram rider and finally the 1 gram rider. You are able to measure the weight of an object to the nearest 0.1 gram. The weight of the object is the sum total of the riders.

Examine the following illustration:

**Reading:** 156.8 grams

**Total:** 156.8 G
4. Record the weight of each object listed on the Data Chart. **THEN check your accuracy** by using the electronic digital scales.

*Include units!*

**DATA CHART**

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>WEIGHT: GRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>penny:</td>
<td>2.3 g (units)</td>
</tr>
<tr>
<td>paper clip</td>
<td></td>
</tr>
<tr>
<td>any irregular shaped object from Part II</td>
<td>71.4 g</td>
</tr>
<tr>
<td>graduated cylinder (empty and dry)</td>
<td>144.1 g</td>
</tr>
<tr>
<td>graduated cylinder with 100 ml of water</td>
<td>144.1 g</td>
</tr>
</tbody>
</table>

* *1 mL of H₂O = 1 cm³ of H₂O = 1 g of H₂O*

**OBSERVATIONS:**

Determine the mass of 100 ml of water:

- 1 mL of water: 1 g
- 1 L (1000 ml) of water: 1000 g

**CONCLUSIONS:**

*Read p. 21 in your book to help answer the questions below.*

A. Using the terms: **CONSTANT** and **VARIES**, explain how the mass of an object differ from the weight of that same object?

B. **How is the Triple Beam Balance different from the scale in your Bathroom?**

C. **If you were on the Moon, you would weigh @1/6 th (.16) of your present weight. Explain.**

Because the gravitational field on the Moon is less than that of Earth, you would weigh less.
Matter is defined as anything that has mass and volume.

Mass is measured using tools called TSS, which includes a balance.

Volume is measured using tools called graduated cylinders, which include metric rulers and graduated cylinders.

Volume is measured in units called mL (milliliters), and mass is measured in units called g (grams).

Units used to measure regular solid volume include cubic centimeters (cm³).
Lesson 4: Matter, mass, and volume

Subject: Science  Unit: Chemistry  Level: 8  Sections: 9, 10, 11, 12

I. Targets

Students will be able to:

- define matter and name various examples of matter.
- define mass, explain how to measure it, and use the correct standard units for mass.
- define volume, explain how to measure it, and use the correct standard units for volume.
- list the three states of matter, as well as their defining characteristics.
- use microscopic diagrams to explain the characteristics of each state of matter.
- name various examples of solids, liquids, and gases.

II. Standards

This lesson will focus on the following Pennsylvania state standards:

- 3.1.10.B: Describe concepts of models as a way to predict and understand science and technology.
  - Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory, DNA).
  - Examine the advantages of using models to demonstrate processes and outcomes (e.g., blue print analysis, structural stability).
- 3.4.10.A: Explain concepts about the structure and properties of matter.

III. Materials

I will utilize the following materials:

- Wooden block and orange Styrofoam sphere
- Triple beam balance
- 500mL beaker with water inside
- Metric ruler
- Laptop, LCD projector, and flashdrive with “matter” keynote presentation
- Matter skeleton outline (120 copies)
- Matter overhead outline
- Overhead projector, overhead transparencies, and overhead transparency markers
- Metal cube
- Plastic bag with water inside
- Graduated cylinder
- Broomstick balance apparatus
- Pitcher
- Vinegar and baking soda
- Towel

IV. Procedure

- Before class
  - Place the wooden block and the Styrofoam sphere on the front table
  - Write the following directions on the board:
    - In your notebooks, define the term “matter.”
  - Place triple beam balance, 500mL beaker with water, metal cube, plastic baggie of water, pitcher, baking soda, and vinegar on the front side table
  - Place the broomstick balance apparatus behind the front table
  - Move overhead projector into place and test it
  - Move LCD projector into place, connect it to the laptop, plug in the flashdrive, bring up the keynote presentation, and test the entire system

- During class
  - Greet students at the door
  - Direct them to the opening activity on the board
  - Gain their attention
    - Ask students to share their definitions
    - Challenge them to use their definitions to describe the wooden block and the sphere as examples of matter
    - Ask students to pass in their definitions
    - Tell them the purpose of the lesson
  - Ask students to compare the two objects
    - Write down examples such as color, shape, and size
    - Discuss them as properties
    - Challenge students to identify the two general properties that define all matter (i.e. mass and volume)
  - Ask students to create a new definition of matter
  - Discuss why matter has mass and volume, use the keynote presentation
  - Ask students to identify examples of matter in the classroom (i.e. EVERYTHING!)
  - Pass out the skeletal outline and fill out the top half
  - Move to states of matter table
    - Go through keynote slides of each state
    - Go through skeletal outline of each state
    - Challenge students to offer answers for the blanks in the tables
- Prove the characteristics of all three states by running through the mini demos
- Discuss mass and volume and complete the bottom half of the skeletal outline
- Challenge students to summarize what they learned in class
- Issue homework: read pages 8 and 9 in the textbook and answer questions 1 through 3 on page 9

V. Assessment

I will assess my students in the following ways:

- I will determine my students' current understandings of matter by reviewing the definitions they submit.
- After creating a new definition of matter, I will reassess my students' understandings of matter by asking them to identify and explain various examples of matter.
- I will determine how well my students understand the states of matter by asking them to use the structural properties of each to explain the defining characteristics of each.
- I will determine what knowledge my students gain by asking them to verbally summarize the lesson.
- I will determine how well my students understand mass and volume by reviewing their homework assignments.

VI. Actual time required and actual activities completed

I completed the entire lesson in one regular class period. This was the amount of time that I had originally planned for. A number of things allowed me to accomplish this. First, I used an overhead projector to display the opening activity for my students. I also stood at the door and instructed my students to read the overhead as they walked into class. As a result, my students immediately began to write their definitions. Second, I provided my students with skeletal notes, which we filled out together as the lesson progressed. This allowed my students to quickly and easily identify and organize important information. It also gave structure to the lesson as a whole.

Still, despite completing the lesson in the right amount of time, I was not able to perform all of the demonstrations I originally planned. Specifically, I was not able to perform the demonstration involving carbon dioxide gas and the broomstick balance apparatus. This demonstration would have allowed my students to visually confirm that gases flow and have mass. However, after attempting the demonstration multiple times before school, I was unable to successfully complete it. I admit that I did not attempt the demonstration until the actual day of the lesson. This was irresponsible of me. I need to attempt demos and labs at least two days in advance so that I may adjust my lessons appropriately. Thankfully, I found a double syringe system, and I used it to prove the three characteristics of gases.
Teacher as an ...
- Expert in school context
- Instructional leader
Reflection
Teacher as an expert in school context and as an instructional leader

When my students measured mass and volume during their first lab, there was one particular section of the lab that alluded to density. Specifically, my students used triple beam balances to measure the masses of three different cylinders. The cylinders all shared the same shape and coloring. However, one of the cylinders was 8cm long, one was 5cm long, and one was 3cm long. Despite their differences in size, all three cylinders had the same mass. My students were perplexed by the fact that cylinders so different in size had the same masses. One student said, “Mr. Cunzolo, this cylinder is so much smaller than this one but we keep finding that they have the same masses. Is there something wrong with our triple beam balance?” I informed this student that the balance was correct, and I asked him to provide another explanation for this interesting phenomenon. Neither he nor any other student could successfully do so.

This alarmed me as our next section in the chemistry unit focused on density. Constructivist learning theory asserts that meaningful learning cannot take place unless students have prior knowledge to which they can relate new ideas. If the material being presented fails to overlap with existing knowledge structures, then students may struggle to process and to truly acquire it. Based upon my initial questions during the first lab, it appeared as though my students possessed little knowledge of density.

In order to thoroughly assess their prior knowledge, I administered a pre-assessment quiz. The first question challenged my students to define density. Only 6% of my students were able to do so. The third question provided my students with a known mass and density and asked them to calculate volume. Only 10% of my students were able to do so. The fourth question provided my students with a known volume and mass and asked them to calculate density. Only 27% of my students were able to do so. Finally, the fifth question asked my students to diagram the results of placing five liquids with different densities into a graduated cylinder. Only 26% of my students were able to do so.

The pre-assessment clearly established that my students possessed relatively little knowledge about density. Under such circumstances, constructivist theory suggests that teachers do two things. First, teachers should provide actual experiences to which students can relate new information. Second, teachers should utilize analogies in order to relate new information to familiar concepts.

With this in mind, I decided to begin the density section with a simple demonstration. I knew this would provide my students with an actual experience they could use to understand density. Basically, I placed two unopened pop cans of the same size and shape into a fish tank filled with water. One floated and the other did not. I then challenged my students to explain this phenomenon. After initial discussion, I presented three large test tubes filled with sugar. I explained that 52g of sugar were packed into the can that sank. Next, I presented a small test tube with only 188mg of aspartame inside of it. I explained that this small amount of aspartame was inside of the can that floated. I then asked my students to use the new information to explain why the cans differed in their abilities to float. My students began to say, “Both cans have the same volume but one has a lot more packed into it. Since it’s more compacted it probably has a greater mass so it sinks.” With that, I introduced the term “density.” Based upon this initial demonstration, my students began to understand density as a measure of how much “stuff” was packed into an object.

Continuing to follow constructivist principles, I transitioned from the demonstration to a real world analogy. Specifically, I asked my students if they could define population density. Their hands immediately flew into the air. They were able to inform me that population density was a measure of how many people were packed into a specific area. After establishing this definition, I wanted my students to physically model population density so they could see and feel the effects of
I asked six students to enter the square. Each of them represented 1,130 people and together they represented Pittsburgh. I asked one of the students to describe what he felt and observed. He said, “There is a lot of extra room between us so we can like, spread out.” Next, I asked 18 more students to enter the square. This placed a total of 24 students within the square. Each of them represented 1,130 people and together they represented New York City. I then asked the same student to once again describe what he felt and observed. This time, he said, “There is like, no extra room now. I feel a lot more squished because we are all so packed together.”

We then performed the same activity a second time. However, instead of comparing cities, we compared water and tungsten. I provided my students with the densities of each, and I informed them that each student would represent one gram. I also challenged them to explain any change in density in terms of mass and volume. One of my students concluded, “Ok. Water and tungsten had the same volume, but there were a lot more of us inside the volume for tungsten. So, they were different in how much mass was compacted into the amount of volume.” This was amazing! My students used a demonstration and a simple analogy to arrive at their own understanding of density. Although I guided them, my students used their experiences and their observations to form their own inferences about density. In doing so, my students created their own schemas with which they could interpret and assimilate any new information related to density.

With this established, I presented my students with the official definition for density. I also discussed the formula for calculating density. Beforehand, fellow science teachers informed me that their students consistently struggled to acquire and recall the formula for density. With this in mind, I decided to use two different memory devices to promote the acquisition and fast recall of the density formula. First, I presented the density heart. My students created a heart and drew a horizontal line across it. This split the heart in half, leaving an “M” on top of the line and a “V” on the bottom of the line. Second, I presented the density triangle. This organized mass, volume, and density in such a way that my students could use it to determine the formulas for all three values. My students thought both of these memory devices were fun and helpful. At the end of class, when I asked a few review questions, my students used their density triangles to construct their answers. They proved to themselves that they did not have to memorize all three formulas.

Still, it was not enough for my students to simply know and recall information related to density. They had to be able to accurately use mass and volume to calculate density. I knew my students could not effectively learn these procedures by listening to a lecture. Furthermore, I would not be able to assess their procedural skills unless they physically performed the skills. For this reason, I decided to create a lab activity during which my students investigated density.

The most important aspect of this lab was that it challenged my students to use their knowledge of density to understand real world issues. For example, they needed to use their knowledge of density to generate ideas for cleaning an oil spill. They needed to explain why the Titanic floated and why it sank. They also needed to explain how balloonists controlled the heights at which they flew their hot air balloons. Such questions challenged my students to elaborate on their knowledge of density. Constructivist learning theory asserts that students learn and remember new material more effectively when they elaborate on it. This may be due to the fact that such elaboration forces students to actually use the material. When they do so, they actively process the material and store it within their long-term memories. Thus, by challenging my students to use their knowledge to explain real world issues, I provided them with opportunities to efficiently process and store information related to density.

The ultimate proof of the effectiveness of my instructional strategies was found in the results of the ensuing density quiz I administered. On this quiz, I strategically included the four questions I
analyzed during the pre-assessment quiz. I compared the percentages of the students who correctly answered the questions on the pre-assessment to the percentages of students who correctly answered the questions on the post-assessment. On the post-assessment, 66% of my students, as compared to 6% on the pre-assessment, were able to correctly define density. On the post-assessment, 98% of my students, as compared to 10% on the pre-assessment, were able to correctly calculate volume. On the post-assessment, 96% of my students, as compared to 27% on the pre-assessment, were able to correctly calculate density. Lastly, on the post-assessment, 94% of my students, as compared to 26% on the pre-assessment, were able to correctly order immiscible liquids in a graduated cylinder. The level of improvement was drastic.

I owe my success during this section to a colleague of mine. Prior to implementing the lessons of my density section, I observed Mrs. Caren Falascino, who was an instructor in Upper Saint Clair's international baccalaureate program. Inquiry was a major aspect of her instructional approach. Specifically, she provided her students with opportunities to experience new topics before she presented official terminology and explanations. She allowed her students to construct and to explain their own mental models first. Only then did she quickly explain the concept, before presenting her students with yet another inquiry investigation. I noticed that Mrs. Falascino’s students were motivated to learn. They actively engaged the material, participated in classroom discussions, and worked together to construct a collective understanding of the material.

This was not how I originally planned my density section. Originally, I planned to begin the section by presenting a lecture on density. Afterwards, I planned for my students to complete a simple lab activity.

However, after observing Mrs. Falascino motivate and enable her students to succeed, I knew I needed to alter my plans. I decided to let my students investigate density and create their own definitions before I lectured on the topic. I also kept my lecturing to a minimum, and I placed more of the responsibility for learning upon my students. In doing so, I enabled them to construct their own knowledge structures. I also used social interaction and personal freedom to motivate my students.

This experience provides evidence of my growth as an expert in school context and as an instructional leader. As an expert in school context, I was able to foster relationships with colleagues in order to support student learning. During this section, I developed a relationship with a veteran science teacher. After observing her, I reflected on my instructional strategies, and I used her advice to improve them. With her guidance, I was able to effectively foster the cognitive growth of my students. As an expert in school context, I also identified the academic needs of my students before proceeding with academic content. I then planned my instruction around my student's needs and abilities. As an instructional leader, I was able to engage in shared leadership with other teachers. Instead of holding onto the way I wanted to present density, I consulted with other teachers. I observed their teaching styles, and I asked them to identify problem areas for me. In other words, I used their experiences and their advice to create effective lessons. As stated above, this required me to modify my original plans. Instructional leaders accept the fact that change is inevitable in the classroom. Lastly, as an instructional leader, I was able to identify a major problem. Specifically, I discovered that my students possessed little background knowledge on density. I reacted to this problem by analyzing it and using learning theories to solve it. I also assessed it at the end of the density section. Leading teachers do not overlook problems. Instead, they analyze problems and plan accordingly.
Evidence
&
Lesson plan
Evidence of student learning

At the beginning of the density section, I administered a pre-assessment quiz. On this quiz, I asked my students to do a number of things. I asked them to define density, calculate mass, calculate volume, calculate density, and order a set of immiscible liquids within a graduated cylinder. This pre-assessment allowed me to determine how well my students understood density before beginning the section.

At the end of the section, I administered a post-assessment quiz. On this quiz, I included slightly modified versions of four of the five questions I included on the pre-assessment quiz. Specifically, I asked my students to define density, calculate volume, calculate density, and order a set of immiscible liquids within a graduated cylinder. This allowed me to compare the percentages of the students who correctly answered the questions on the pre-assessment to the percentages of students who correctly answered the questions on the post-assessment. This comparison allowed me to assess how well my students acquired and recalled the information from the density section. The comparisons are summarized below:

<table>
<thead>
<tr>
<th>Questions</th>
<th>% of students correct on pre-assessment</th>
<th>% of students correct on post-assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defining density</td>
<td>6</td>
<td>66</td>
</tr>
<tr>
<td>Calculating volume</td>
<td>10</td>
<td>98</td>
</tr>
<tr>
<td>Calculating density</td>
<td>27</td>
<td>96</td>
</tr>
<tr>
<td>Ordering immiscible liquids</td>
<td>26</td>
<td>94</td>
</tr>
</tbody>
</table>
Density pre-assessment

1. Write a definition for density.

2. What would be the mass of a 7.0 mL sample of material if it had a density of 5.0 g/mL?
   a. 0.71 g  
   b. 1.4 g  
   c. 2.0 g  
   d. 12 g  
   e. 35 g

3. What would be the volume of a 7.0 g sample of material if it had a density of 5.0 g/mL?
   a. 0.71 mL  
   b. 1.4 mL  
   c. 2.0 mL  
   d. 12 mL  
   e. 35 mL

4. Calculate the density of a material for which a 6.4 mL sample has a mass of 13.203 g.
   a. 0.48 g/mL  
   b. 0.48473 g/mL  
   c. 2.0629 g/mL  
   d. 3.1 g/mL  
   e. 6.8 g/mL

5. If you poured five different liquids into a graduated cylinder, what would happen? Explain your answer. Also, draw and label a diagram of your prediction.

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Density g/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maple syrup</td>
<td>1.37</td>
</tr>
<tr>
<td>Rubbing alcohol</td>
<td>0.87</td>
</tr>
<tr>
<td>Dawn soap</td>
<td>1.03</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>0.91</td>
</tr>
<tr>
<td>Colored water</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Part I. Knowledge

1. The two most important **general properties** of matter are **mass** and **volume**.

2. **True/False** – The mass of a substance equals the weight of a substance.

3. **True/False** – Volume is defined as the amount of space that a substance occupies.

4. Density is defined as \( \text{mass} = \text{volume} \).

5/6. In the space below, draw the density triangle and list the formula for density.

\[
\text{Density} \quad \frac{\text{mass}}{\text{volume}}
\]

Part II. Understanding

7. Object A has a density of 2g/cm³. If object A is cut into two equal parts, what will be the density of one half? Of the other half? Why did the density of object A not change after it was cut into two smaller pieces? Answer below.

8. Why did the density of object A not change after it was cut into two smaller pieces? Answer below.

   A. Density is a general property of matter. Therefore, it remains constant even when the size of object A changes.
   B. Density is a characteristic property of matter. Therefore, it remains constant even when the size of object A changes.
   C. There must have been an error with the equipment that was used to determine the mass and volume of object A.

9. If you were asked to identify an unknown element, how would you use mass, volume, and density to complete your investigation?

10. Object A and object B are placed in a container of water. Object A sinks to the bottom, while object B floats at the top. What can you conclude about the densities of objects A and B?

   A. Object A is denser than object B.
   B. The density of object B is smaller than the density of water.
   C. All of the above
11/12/13. You are given two different liquids, one solid, and their respective densities. You are asked to place these items in a graduated cylinder. Draw the resulting cylinder, the order of the liquid layers, and the location of the solid piece. **MAKE SURE TO LABEL YOUR DIAGRAM!**

Liquid 1 - 2.6g/mL
Liquid 2 - 2.0g/mL
Solid - 2.5g/mL

**Part III. Performance**

14. Calculate the density of a material for which a 5mL sample has a mass of 20g.
   a. 5g/mL  b. 40g/mL  c. 100g/mL  d. 10g/mL  e. 4g/mL

15. Calculate the volume of a 14.0g sample of material if it had a density of 7.0g/mL.
   a. 28mL  b. 3mL  c. 2mL  d. 12mL  e. 35mL

****** List the station you are using **********

16. What is the volume of water in the graduated cylinder?

17. What is the mass of the metal rod?

18. Assuming the metal rod has a volume of 7cm³, calculate the density of the rod. **SHOW YOUR WORK AND CIRCLE YOUR ANSWER!**

   \[ D = \frac{m}{V} \]
   \[ D = \frac{1.64g}{7cm^3} = 0.2343g/cm^3 \]

19/20. List the names of the two pieces of lab equipment at your station.

   Equipment A:  Equipment B:  test tube stand rack
Lesson 8: Introduction to density

I. Targets

Students will be able to:

- make observations.
- use observations to make predictions and to explain a density related phenomenon.
- define density.
- create a model for density.
- use the density triangle to list the formulas for density, mass, and volume.
- complete mathematical problems involving density, mass, and volume.

II. Standards

This lesson will focus on the following Pennsylvania state standards:

- 3.1.10.B: Describe concepts of models as a way to predict and understand science and technology.
- 3.2.10.B: Apply process knowledge and organize scientific and technological phenomena in varied ways.
  - Describe materials using precise quantitative and qualitative skills based on observations.
  - Use process skills to make inferences and predictions using collected information and to communicate, using space / time relationships, defining operationally.
- 3.4.10.A: Explain concepts about the structure and properties of matter.

III. Materials

I will utilize the following materials:

- Fish tank filled with water
- Case of Coke Classic cans
- Case of Diet Coke cans
- 50mL beaker with 45g of sugar
- Index card with 188mg of NutraSweet
- Density introduction guide (120 copies)
- Density introduction guide (overhead)
- Overhead projector, transparencies, and transparency markers
- Rope
- Large density triangle made on construction paper (three puzzle pieces)
- Density pre-assessment quiz (120 copies)

IV. Procedure

- Before class
  - Fill the fish tank with water and set it on the front table
  - Set the rope on the front table
  - Place one regular Coke and one diet Coke at each group table
  - Fill 50mL beaker with 45g of sugar, place behind front table
  - Place 188mg of NutraSweet on an index card, place behind front table
  - Divide density introduction guides
  - Move overhead projector into place and test it
  - Place the pieces of the density triangle on the back table face down

- During class
  - Greet students at the door
    - Hand each student a copy of the density pre-assessment quiz and a copy of the introduction guide
    - Tell students to begin by filling out the pre-assessment quiz and then to complete step one of the coke investigation
  - Gain the attention of the class
    - Collect pre-assessment
    - Tell them they have two minutes to complete their observations
    - After two minutes, tell them to move onto step 2
    - After they complete step 2, proceed with the demonstration
    - Challenge students to explain the demonstration
    - Present the sugar and the NutraSweet, as well as they actual explanation
      - Regular Coke and Diet Coke are the same size and have the same volume
      - However, regular Coke has a lot more sugar packed into that volume (39,000mg versus 188mg)
      - Regular Coke is denser
  - Ask if anyone has ever heard about density and if anyone has a definition
  - Proceed to explain density by discussing and modeling population density
    - Have four students pull the piece of rope into a 5x5 square
    - This represents one square mile
    - To represent Pittsburgh, have 6 students stand inside the square
    - To represent New York City, have 24 students stand inside the square
    - Ask students to describe what it feels like to go from an area with 6 people to an area with 24 (crammed, packed)
- Perform the same exercise but speaking in terms of mass and volume
  - Have four students pull the piece of rope into a 5x5 square
  - This represents one cubic centimeter
  - To represent Water, have 1 student stand inside the square
  - To represent Tungsten, have 20 students stand inside the square
  - Ask students to describe what it feels like to go from a volume with 1 person to a volume with 20 (crammed, packed)
- Density is the amount of matter (mass) that is crammed into a defined amount of space (volume)
  - Density is mass per volume
- Proceed with math example
  - How fast are we traveling if we travel 10 miles in 10 hours?
    - 10mi per hour
  - How did you figure that out?
    - Miles divided by hours
  - This shows us that the word “per” is synonymous with the phrase “divided by”
  - If density is mass per volume then it must be \( D = \frac{M}{V} \)
- Show the density heart
- Construct and explain the density triangle
- Pass out density drill homework
- Finish with two exit slip questions
  - Calculate the density of a 10g object with 5cm\(^3\) of volume (2g/cm\(^3\))
  - Calculate the mass of a 20cm\(^3\) object with a density of 5g/cm\(^3\) (100g)

V. Assessment

I will assess my students in the following ways:

- I will challenge them to make observations and to use them to explain the Coke demonstration. This will allow me to assess their ability to make and use observations. It will also allow me to assess their initial understanding of density.
- I will challenge my students to create and to use a model to explain density. They will also use this model to explain why tungsten is denser than water. This will tell me if my students understand the concept of density.
- I will challenge my students to answer two density related math problems at the end of the class. I will also give them a homework assignment that focuses on calculating density, mass, and volume. This will tell me if my students understand the relationship between density, mass, and volume. It will also tell me if my students know how to use the density triangle.
VI. Actual time required and actual activities completed

I originally planned to complete this lesson during one regular class period. As the dates at the top of the lesson plan reveal, I was unable to accomplish my original goal.

Prior to implementing this lesson plan, the eighth grade science teachers held a meeting in order to review the academic schedule for the rest of the year. Due to a few changes from the previous year, we lost two whole days of instruction in November. This forced the eighth grade science teachers to map out the exact dates of every quiz and test for the rest of the academic year. After doing so, I realized that I had more lessons on density than I did days of instruction. Specifically, I had one lesson too many. I needed to eliminate one lesson if I wanted to administer the density quiz on time. I had to provide my students with enough time to complete and to review their density labs. Therefore, I thought I would be forced to abandon my eighth lesson.

Thankfully, I encountered some available time at the end of my seventh lesson. I used this time to complete the first portion of my eighth lesson. That is to say, I administered the density pre-assessment quiz, and I completed the pop can demonstration. My students had plenty of time to record and to discuss their observations and their explanations. I also had plenty of time to provide the official explanation for the demonstration, as well as a very simple definition for density.

This allowed me to complete the second half of my eighth lesson on the following day, without sacrificing the amount of time my students had to complete their density labs. I was quite happy that I was able to implement this lesson. Although the density lab would challenge my students to develop deeper understandings of density, the eighth lesson motivated my students and it laid the groundwork for the rest of the density section. This included time spent defining density and discussing its mathematical relationship with mass and volume. What is more, the lesson included interesting demonstrations and analogies that allowed my students to encounter density in practical ways.

In spite of my adjustments, there was one change to this lesson. I originally planned to assign a density math worksheet as homework on the day I completed my eighth lesson. However, due to schedule changes, I had my students complete the first section of their density labs on the same day that I finished my eighth lesson. I assigned the conclusions for this section as homework. Because the conclusion section was rather large, I decided that it would be too overwhelming to also require my students to complete the math worksheet. Therefore, I decided to assign it as homework on the second day of the density lab.
Teacher as a ...
- Master practitioner
Reflection
Teacher as a master practitioner

During the second nine-week grading period, I inherited full responsibility for 110 eighth grade students. Due to the fact that the second nine-weeks focused on chemistry, one of my major responsibilities was planning lab activities. This challenged me to construct meaningful, organized, and safe laboratory experiences. It also challenged me to create lab packets, which would guide my students through their lab experiences. Originally, I thought it would be quite easy to create lab packets that would direct student activity and thought. After implementing and reviewing the first major lab, I realized the challenge of creating a good lab packet was far above what I originally conceived.

The first major lab activity focused on density. It was divided into three separate parts: solids, liquids, and gases. This allowed students to focus on one state of matter at a time, as they practiced the necessary procedures for measuring density. Within the lab packet, I provided essential background information, simple directions, and tables for organizing data. Most importantly, I included thought provoking questions, which guided my students toward a basic understanding of density. These questions challenged my students to use their data to form conclusions about density. They were also challenged to draw models, and they were challenged to read about the importance of density in everyday life. Everything was meaningful and organized. I thought I created the perfect guide.

However, the scores my students achieved indicated otherwise. While grading the lab packets, I realized the majority of my students performed poorly. Some of my best students received scores in the 60% range. This really confused me. During the actual lab, my students conducted the activity accurately and safely. When I asked them questions regarding density, they were able to answer me correctly. It appeared as if they understood the concepts involved.

In order that I might determine where my students missed their points, I decided to review the labs. What I found amazed me. First, although the majority of my students recorded accurate data, they failed to include the proper units (form A). Second, my students tended to only partially answer multistep questions (form A). They did not struggle to understand the concepts. Instead, they struggled to follow directions.

I became very curious as to why my students failed to follow the directions in their lab packets. As I reflected on this issue, I realized the format of the lab packet was rather confusing. First, I included the units for the headings of each column in each data table, and the directions never explicitly told my students to include units with each piece of data. Since the units were located at the top of each column, I understood why some of my students did not include units. Second, my multistep questions were improperly formatted for eighth grade students. Instead of separating the questions vertically, I formatted them in paragraph form. From my prior experiences, I knew eighth grade students struggled with such formatting. They tended to quickly read and answer the first question, but they often forgot to finish the remaining questions. Knowing this, I should have used an outline format to vertically separate multistep questions. This format would have enabled my students to accurately follow directions. In the end, I realized my poor decisions greatly influenced the performance of my students.

Instead of punishing my students for my mistakes, I decided to turn the first major lab into a major learning opportunity. Everyone received a ten out of ten for their efforts, but they also received their lab packets with all incorrect answers thoroughly noted. During this time, I apologized for my poor decisions, and I provided students with the opportunity to offer suggestions for improvements. I also explicitly outlined my expectations for the completion of future labs. My students had a lot to say, and they were very grateful for the opportunity to learn.
Such conversations, as well as my time of personal reflection, allowed me to learn a few things. First, students are not solely responsible for poor performance. The instructional strategies and tools teachers utilize greatly affect students' abilities to succeed. Second, teachers cannot be afraid to apologize for and to correct their mistakes. Professional educators, just like their students, are learners for life. Learners make mistakes. Good learners account for their mistakes. Third, when students struggle during an activity, they need the opportunity to openly discuss their issues and to make suggestions. They know where they are weak, and they can help teachers strengthen these areas. Finally, students (at least in eighth grade) benefit from receiving explicit and simple directions. They also perform better when they know the expectations of their teachers. Minimizing any possible confusion allows students to focus solely on comprehending the concepts at hand.

Although I was thankful when the density lab ended, I knew I was responsible for implementing what I learned. During future labs, I explicitly noted when I wanted students to use complete sentences and to include proper units (form B). I highlighted, underlined, and starred important directions (form B). I included questions that were straightforward, and I separated them vertically (form C). Essentially, I did everything I could to enable my students to follow directions and to avoid confusion.

I immediately noticed differences in the way my students completed their lab packets. During class, they constantly asked me questions about units and complete sentences. They wanted to know exactly when to use both items. They also met with me in order to confirm the questions I expected them to answer. Essentially, they appeared to be a lot more concerned about properly completing their labs. Aside from their attitudes, the work my students submitted began to meet my expectations. They included detailed observations (form C), accurate data with units (form B), comprehensive graphs (form B), and well-formed conclusions (forms B/C). The level of work they submitted drastically improved.

In the end, my students and I both improved as a result of this experience. My students learned how to carefully follow directions, and they learned how to ask questions when they became confused. I learned to clearly present my expectations, and I learned how to format lab activities in a way that was easy to understand. Most importantly, I discovered the value of personal reflection. It is quite easy to implement a lesson without ever taking time to consider its effectiveness. I realize now that such ignorance restricts a teacher from discovering and correcting their mistakes. I want to improve, and I want to mature. I want the same things for my students. However, this will never occur if I continually make the same mistakes. Developing my ability to humbly reflect on my instructional decisions will allow me to become the proficient and distinguished teacher I truly desire to be.

My ability to humbly reflect and to use my reflections to make wise instructional decisions points to my development as a master practitioner. Furthermore, as a master practitioner, I actively sought opportunities to enhance professional growth in both my students and myself. I took time to thoroughly review the density lab. During this review, I identified the mistakes my students made, and I taught them how to accurately complete future labs. Making connections to real world events such as job applications, I explained why it was important to use complete sentences and to follow directions. I also allowed my students to offer suggestions for how I could improve my presentation of the labs. Working together to support learning definitely required my students and I to act professionally. Lastly, as a master practitioner, I used labs and the review session to develop problem solving and performance skills among my students. They had to analyze the questions in the labs, and they also had to analyze their mistakes. Such analysis allows students to apply their new skills outside of the academic classroom.
Evidence
&
Lesson plan
Everything around you is composed of various elements, which are organized on the periodic table. These elements combine with one another in specific ratios. The types and the amounts of the elements within these combinations determine the properties of any piece of matter. These properties are used to describe matter. A few general properties include mass, volume, color, shape, size, texture, odor, and state. Such properties vary greatly. Aside from general properties, there are also characteristic properties. Such physical and chemical properties are unique to a particular substance. Therefore, they are relatively constant and predictable.

**Density** is an example of a characteristic property. It is basically the ratio of mass and volume. Unlike many observable properties, density is a property of matter that does not change. It is unique to a piece of matter just like DNA or fingerprints are unique to a person. For this reason, density has many important uses. During this lab, you will thoroughly investigate density, its importance, and the role it plays in everyday life.

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**Part 1a: Solids**

**Materials:**

- Triple beam balance/Electronic scale
- 100mL graduated cylinder
- Set of seven blocks
- Copper cylinder
- String with loop
- Metric ruler

**Procedure:**

1. Write a definition for density. Next, write out the formulas for calculating density, mass, and volume.
2. Complete the following table using procedures and equipment from lab 1.

<table>
<thead>
<tr>
<th>Object</th>
<th>Mass (g)</th>
<th>Volume (cm$^3$)</th>
<th>Density (g/cm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al block, small</td>
<td>2.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al block, large</td>
<td>1.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White plastic, small</td>
<td>7.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White plastic, large</td>
<td>4.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear plastic, small</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear plastic, large</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooden block</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper cylinder</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions:

Below, you will find cubes that represent the materials you worked with during this lab. Write the densities of each material inside their respective cubes.

<table>
<thead>
<tr>
<th>Material</th>
<th>Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>2.7 g/cm³</td>
</tr>
<tr>
<td>Clear plastic</td>
<td>1.2 g/cm³</td>
</tr>
<tr>
<td>White plastic</td>
<td>0.98 g/cm³</td>
</tr>
<tr>
<td>Wood</td>
<td>1.62 g/cm³</td>
</tr>
<tr>
<td>Copper</td>
<td>8.9 g/cm³</td>
</tr>
</tbody>
</table>

2. Based upon your results, were the densities of the different materials the same or were they different? Did each material have its own unique density? Provide examples.

They were the different, and each one had its own unique density. One example is the white plastic was 0.98, while the copper was 8.9.

3. Refer to the small and large aluminum blocks when answering the following question: Does a change in the mass or the volume of an object affect its density? How do you know this? Examine the rest of the small and large blocks. Does your conclusion hold true for all of them?

It does not affect its density because every material has the same density. I know this because the white plastic has the same density throughout the process.

4. Read “Density as a characteristic property” on page 20 and “Mass or weight” on page 21 of your book. Based upon the reading and your answers to questions two and three, what can you conclude about the uniqueness of density? Knowing this, how could density be used to identify the substance from which an object is made? Each material has its own density, and on quiz finish question.

5. You will find an unknown object at the front of the classroom. Its mass and its volume are listed. Calculate its density and use page 80 in your book to identify the substance. **YOU MUST SHOW YOUR WORK.**

\[
\text{Density} = \frac{\text{mass}}{\text{volume}} = \frac{6.1 \text{ g}}{5 \text{ mL}} = 1.22 \text{ g/mL}
\]

Nylon units?
Part 1b: Solids

Materials:
- 1000mL beaker filled with 700mL of water
- Set of seven blocks

Procedure:
One at a time, place each object in the 1000mL beaker. Record whether each object floats or sinks.

<table>
<thead>
<tr>
<th>Object</th>
<th>Density (from part 1a)</th>
<th>Float or sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al block, small</td>
<td>2.7 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Al block, large</td>
<td>2.6 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>White plastic, small</td>
<td>1.1 g/cm³</td>
<td>Float</td>
</tr>
<tr>
<td>White plastic, large</td>
<td>2.7 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Clear plastic, small</td>
<td>1.3 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Clear plastic, large</td>
<td>0.8 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Wooden block</td>
<td>1.6 g/cm³</td>
<td>Sink</td>
</tr>
<tr>
<td>Copper cylinder</td>
<td>8.9 g/cm³</td>
<td>Sink</td>
</tr>
</tbody>
</table>

Conclusions:

1. The density of water is 1.0g/cm³. Knowing this, does a relationship exist between the density of an object and its ability to float in water? If so, describe what this relationship is. Provide an example that proves your conclusion.

2. One of the most famous people to ever experiment with water and floatation was Archimedes. His experimentation lead to several amazing discoveries. Read about them on pages 22 and 23 in your book and answer the following question: did Archimedes prove that the crown was made of pure gold? Explain the evidence he used to form his conclusions.

3. The Titanic definitely earned its name. It was almost 900 feet in length (3 football fields), and it weighed around 46,000 tons (92,000lbs)! Read pages 28 through 29 in your book and answer the following questions: What role did density play in allowing this massive ship to float, and what role did density play in allowing this massive ship to sink?
**Part 2: Liquids**

All liquids are examples of matter. Based upon the definition of matter, all liquids have mass and volume. Therefore, any liquid also has its own specific density, which can be calculated just as it was for solids.

**Materials:**

- Triple beam balance/Electronic scale
- Vegetable oil
- Three 100mL graduated cylinders
- Maple syrup
- 250mL beaker with colored water
- One plastic screw

**Procedure:**

1. Write down the steps required for determining the density of a liquid.
   
a. **Mass the empty graduated cylinder.**
   
b. **Pour in the liquid.**
   
c. **Mass the liquid and the graduated cylinder.**
   
d. **Subtract** \[ \text{density} = \frac{\text{liquid mass} - \text{GC mass}}{\text{GC mass}} \]

2. Use the two graduated cylinders and the balance to determine the mass, volume, and density of each liquid. Record your results in the following table:

<table>
<thead>
<tr>
<th>Liquid</th>
<th>Mass of GC (g)</th>
<th>Mass of GC and liquid (g)</th>
<th>Mass of liquid (g)</th>
<th>Vol. of liquid (mL)</th>
<th>Density g/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td>20.9</td>
<td>20 mL</td>
<td>0.99 mL/g</td>
</tr>
<tr>
<td>Oil</td>
<td>43</td>
<td>53.6</td>
<td>10.69</td>
<td>12 mL</td>
<td>0.88 g/mL</td>
</tr>
<tr>
<td>Syrup</td>
<td>42.6</td>
<td>65.4</td>
<td>22.89</td>
<td>18 mL</td>
<td>1.26 g/mL</td>
</tr>
</tbody>
</table>

3. When your chart is complete, tilt the GC with the syrup at a 45-degree angle. Carefully pour the water into the syrup. Then do the same with the oil. Describe what happens to the three liquids, and draw what you observe.

   The less dense liquid rises to the top while the densest material sinks to the bottom.

4. Gently drop the plastic screw into the column of liquids. Describe and draw what you observe.

   The screw travels slower in denser materials. It traveled quickly through the oil and slower through the water. It stopped once it hit the syrup. The screw is more dense than the water but less dense than syrup.

   ![Diagram of liquid densities with screw]
Conclusions:

1. Explain why the two liquids stacked in the order they did.
   - One liquid was denser than the other.

2. Explain why the screw behaved as it did.
   - It traveled faster through the less dense material.

3. If you added liquid mercury (density of 13.5g/mL) to your current column, then where would it form a layer? Explain why and draw it in the space below.
   - It would go to the bottom because it is denser than all the liquids.
   - Oil
   - Water
   - Syrup
   - Mercury

4. If you added a solid piece of lithium (density of .5g/cm³) to your current column, then where would it be located in your column? Explain why and draw it in the space below. Remember 1mL equals 1 cm³.
   - It would float to the top because it has a density less than water and oil.
   - Oil
   - Water
   - Syrup
   - Mercury

5. Oil spills are dangerous events. During an oil spill, thousands of gallons of oil can be released into oceans or coastal waters. The released oil greatly harms seabirds and marine mammals. It also threatens humans by contaminating drinking water, ruining beaches, and making seafood dangerous to ingest. Therefore, it is important to understand how oil behaves in water. From your lab, you know that oil is less dense than water. How can you use this information to devise a cleanup plan for an oil spill?
   - Since the oil is less dense than water, it would float. Once it started to float, I would use a metal sheet under the layer of oil. Next, I would add well connectors to the metal sheet and pick it up out of the water.
Part 3: Gases

Gases do not have definite shapes or volumes. However, they do expand to fill the available space within their containers. Also, because they are examples of matter, gases must have mass. Therefore, gas also has its own specific density. Although it requires a little extra work, the density of a gas can be calculated.

Demonstrations:

- Demo 1 -
1. Draw the balloons as they blow up inside bottles A and B.
2. Why did the balloons behave differently in the two bottles?
   - Bottle A had a hole in it for the air to escape through.

- Demo 2 -
1. Draw the results of water flowing into test tubes A and B.
2. Why did the water behave differently in the two test tubes?
   - In A the air stopped the water by pushing up against the water trying to escape.

Materials:

- Triple beam balance/Electronic scale
- 100mL graduated cylinder
- Nalgene bottle w/valve stopper
- 1000mL beaker for wastewater
- Vacuum pump

Procedure:

1. Make sure to wet the seal of the stopper so it provides a better seal on the bottle. Determine the mass of the sealed bottle with the air inside. Record this mass.
2. Use the pump to evacuate as much air as possible. When the seal stays tightly attached to the bottle, you have removed some air. Determine the mass of the sealed bottle without air. Record this mass.
3. Calculate the mass of the air you removed.
4. To determine the volume of the air, fill the bottle with water. Place the stopper on top to account for the volume it displaces. Pour the water into a graduated cylinder multiple times until there is no water left in the bottle. Add up your results to determine the volume of the bottle. Record this volume.

<table>
<thead>
<tr>
<th>Mass of bottle/stopper/air (g)</th>
<th>Mass of bottle/stopper (g)</th>
<th>Mass of air (g)</th>
<th>Vol. of bottle (mL)</th>
<th>Density of air (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>109.7 g</td>
<td>109.3 g</td>
<td>4 g</td>
<td>62.6 mL</td>
<td>0.007 g/mL</td>
</tr>
</tbody>
</table>
Conclusions:

Calculate the density of air. Make sure to show your work and to include units.

\[ \frac{4 + 636}{1000} \text{ m}^3 \text{ units} \]

2. Balloons filled with helium float effortlessly into the sky when released. Therefore, what can you conclude about the density of helium gas compared to the density of air?

Its density is less than the air's.

3. Read page 34 in your book and answer the following question: Besides the fact that it harmed humans, why was chlorine gas an effective weapon during trench warfare in World War One?

It was effective by being denser than air, therefore it sunk into the trenches.

4. Read pages 35 to 37 in your book and do the following: List two different gases that compose air and explain why they are important to living organisms.

Hydrogen and Oxygen are both present in air. It is important because we need oxygen to survive. In Oxygen we need it for fuel while plants need CO₂.

5. Read page 47 in your book and answer the following questions:

a. Why do hot air balloons float?

They float because when air is heated its density decreases.

Why is it easier to fly a hot air balloon when the surrounding air temperature is cooler (like in the morning) rather than warmer (like in the afternoon)?

Because when the outside air heat it also gets less dense, there is a greater diff in temp. and therefore a greater diff in densities.
Matter can be identified by using physical properties such as density and expansion/contraction. Because matter exists in three states, Solid, Liquid, and Gas, where a material melts/freezes and boils/condenses is unique to that material, and it can be useful for identification. In Part I of this lab you will use the mineral sulfur to illustrate how matter can change state by increasing or decreasing the energy level (adding/removing heat). In Part II, we will record the temperature changes as water goes from ice to steam to see how temperature and phase change are related.

**Part I: Heating sulfur from solid to liquid**

Most rock samples will melt at temperatures that range between 800 degrees and 1200 degrees Celsius. Sulfur is a mineral that will melt at a very low temperature. However, we must use caution when using the mineral because of its low melting point. Sulfur is very easy to burn and change into a gas by placing it under high temperatures. This gas is a pollutant and the amount that is created should be kept at a minimum. Be sure that you never keep the test tubes over the flame for any long length of time.

**Materials:**

- 2 Test Tubes
- 1 sheet of filter paper
- powdered sulfur and spatula
- 1 test tube holder
- glass funnel
- magnifier
- 1 400 ml. beaker
- safety goggles and aprons
- bunsen burner and striker

**Procedures:**

1. Place 1 generous scoop (~ 2 cm in the tube) of powdered sulfur in a test tube. Heat it over the burner for a few seconds then remove it from the heat as it melts to form a clear, light yellow liquid.

   *Do not heat the sulfur to the point where it turns brown!*

2. Make a cone of filter paper inside the glass funnel. Pour the melted sulfur onto the paper in the funnel.

3. Allow the sulfur to begin to cool slowly. Before it hardens completely, remove the paper cone from the funnel and pull it apart to expose the solidifying sulfur. Sketch what you see in the space below. Describe its physical properties. (If you listen carefully, you might even hear an observation...)

   **Ca. sample sketch**

   **b. physical properties**

   Some of the physical properties are it is yellow, shiny, sticky, and some layers are thicker than others.
4. Look at the sample under the magnifier. Again, sketch what you see and identify the physical properties.

**Physical Properties**
- Yellow
- Shiny
- Crystals
- Layered
- Solidified

5. Melt another generous scoop (~2 cm in the tube) in the other test tube as you did in step 1. Place 100 ml of water into the beaker. Then, carefully pour the melted sulfur directly into the beaker with water.

6. Pour the water out of the beaker being very careful not to spill the sulfur into the sink. Remove the sulfur from the beaker and place it next to the sulfur on the filter paper.

7. Sketch what you see and describe the physical properties.

**Sample Sketch**

**Physical Properties**
- Shiny
- Yellow
- Hard
- Rock-like

8. What differences do you notice between the results from the filter paper and the water?

*The filter paper makes the sulfur form in layers. The water solidifies the sulfur into small balls. In the filter paper there were crystals. This was cooled sulfur.*

9. Did you notice the smell of sulfur? In a paragraph explain the states of matter and how they were achieved in this lab.

*The stench of sulfur was released when we heated the tube, and we both noticed the smell.*

In this lab we achieved solids, liquids, and gas. We achieved it by becoming a liquid by adding more heat energy. Another state we achieved solids, and we achieved this by taking heat away. The gas state was achieved by adding heat to make it boil. That is how we achieved each state.
Part II: Heating water from solid to gas

In this section, we will heat water through all its phases from solid to gas and measure the temperature and phase changes along the way. Refer to the directions on pp. 66-67 in your manual to conduct this lab.

Materials:
- 1 250 mL beaker
- 150 mL ice
- safety goggles and aprons
- 50 mL water
- 1 tripod
- bunsen burner and striker
- watch with a second hand
- thermometer

1. Fill in Table 1.

<table>
<thead>
<tr>
<th>Time (min and s)</th>
<th>Temperature of Water (°C)</th>
<th>Observations</th>
<th>Time (min and s)</th>
<th>Temperature of Water (°C)</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0°C</td>
<td>full ice</td>
<td>10 min</td>
<td>60°C</td>
<td>air bubbles rising</td>
</tr>
<tr>
<td>30 s</td>
<td>0°C</td>
<td>small ice</td>
<td>10.30</td>
<td>66°C</td>
<td>steaming</td>
</tr>
<tr>
<td>1 min</td>
<td>0°C</td>
<td>ice melting</td>
<td>11</td>
<td>70°C</td>
<td></td>
</tr>
<tr>
<td>1 min, 30 s</td>
<td>0°C</td>
<td>smaller ice</td>
<td>11.30</td>
<td>74°C</td>
<td></td>
</tr>
<tr>
<td>2 min</td>
<td>0°C</td>
<td>ice melting</td>
<td>12</td>
<td>78°C</td>
<td></td>
</tr>
<tr>
<td>2 min, 30 s</td>
<td>0°C</td>
<td>ice melting a lot</td>
<td>12.30</td>
<td>81°C</td>
<td>starting to boil</td>
</tr>
<tr>
<td>3</td>
<td>8°C</td>
<td>ice melting with</td>
<td>13</td>
<td>87°C</td>
<td></td>
</tr>
<tr>
<td>3.30</td>
<td>10°C</td>
<td>condensing</td>
<td>13.30</td>
<td>90°C</td>
<td>boiling</td>
</tr>
<tr>
<td>4</td>
<td>8°C</td>
<td></td>
<td>14</td>
<td>120°C</td>
<td>air</td>
</tr>
<tr>
<td>4:30</td>
<td>10°C</td>
<td></td>
<td>14.30</td>
<td>145°C</td>
<td>extra heat</td>
</tr>
<tr>
<td>5</td>
<td>11°C</td>
<td>little ice left</td>
<td>15</td>
<td>15°C</td>
<td></td>
</tr>
<tr>
<td>5:30</td>
<td>13°C</td>
<td>ice melted</td>
<td>15.30</td>
<td>97°C</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>17°C</td>
<td>just water</td>
<td>16</td>
<td>75°C</td>
<td></td>
</tr>
<tr>
<td>6:30</td>
<td>24°C</td>
<td>condensing</td>
<td>16.30</td>
<td>19°C</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>21°C</td>
<td>little bubble</td>
<td>17</td>
<td>17°C</td>
<td>check</td>
</tr>
<tr>
<td>7.30</td>
<td>23°C</td>
<td>heat clearing</td>
<td>17.30</td>
<td>17°C</td>
<td>losing water</td>
</tr>
<tr>
<td>8</td>
<td>37°C</td>
<td>conversion</td>
<td>18 min</td>
<td>11°C</td>
<td></td>
</tr>
<tr>
<td>8.30</td>
<td>45°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.30</td>
<td>55°C</td>
<td>bubbles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued)
2. Plot the data from Table 1 on the graph below. Remember to label your axes and include units!

Phase Changes of Water

3. Draw and label your own copy of the diagram drawn on the board. Write a paragraph that explains the shape of the curve on your graph based on the diagram.

Diagram

Explanation

The graph shows a close up view of a phase change. It shows a addition of heat energy to water. The addition of heat lets it go to boiling point. These changes in temp create a phase so go to each state. That is what my graph shows.
When materials are heated, they may change in many different ways. They may simply change color, size, and phase. They may even change into different substances all together. The way in which a substance reacts to heat is a characteristic property of that substance. In other words, different substances behave differently when they are heated. As a result, when a substance is heated, its behavior can be used to identify it. In this lab, you will heat a number of chemicals, and you will describe their reactions.

Materials:
- Bunsen burner
- Striker
- Rubber tubing
- 4 lab aprons
- 4 pairs of goggles
- Ammonium chloride
- Copper (II) sulfate
- Zinc oxide
- Metal spatula
- 7 test tubes
- Test tube rack
- Test tube holder
- Piece of white paper
- Potassium permanganate
- Copper (II) carbonate
- Sodium chloride
- Sulfur

Procedures:
1. Make sure everyone has a lab apron and a pair of goggles on.

2. Setup and light your Bunsen burner.

3. Select chemical number one, and use the metal spatula to put small amount of it into a test tube.
   a. Look at the material in the tube very closely and describe what you see.
   b. Record your observations in the lab chart.

4. Begin heating the chemical by placing the test tube over the flame of the Bunsen burner. Move the test tube back and forth for even heating. Do this for 1 to 2 minutes.
   a. Observe any changes that occur during heating.
   b. Record your observations in the lab chart.

5. Let the material cool for 1 to 2 minutes.
   a. Look at the material in the tube very closely and describe what you see.
   b. Record your observations in the lab chart.

6. Repeat steps 3 through 5 for the rest of the chemicals.

7. Complete the conclusions section on the last page of the lab. Make sure to use complete sentences and proper spelling.
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Appearance before heating</th>
<th>Changes observed during heating</th>
<th>Appearance after heating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur</td>
<td>A yellow powder (solid)</td>
<td>I melted into a liquid and turned into a golden color</td>
<td>Yellow froze into solid crystals</td>
</tr>
<tr>
<td>Ammonium chloride</td>
<td>white powder solid</td>
<td>turning yellow liquid condensation</td>
<td>Solid white rich powder</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>white powder</td>
<td>condenses powder yellow</td>
<td>White powder</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>blue solid</td>
<td>condensing changing to blue at white varising end</td>
<td>formed one solid mostly white some center bly</td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>black solid</td>
<td>condensation purple popping black smoke</td>
<td>Shakes as one piece solid black solid powder</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>white powder</td>
<td>condensation blackening</td>
<td>White powder</td>
</tr>
<tr>
<td>Copper carbonyte</td>
<td>green powder</td>
<td>condensation black bubbling moving like a liquid</td>
<td>Black powder</td>
</tr>
</tbody>
</table>
Conclusions:

1. Which substances showed no changes when they were heated?
The sodium chloride changed the least, out of all the chemicals. None of the chemicals didn't change during the heating.

2. Which substances produced new substances when they were heated?
The potassium permanganate created blue smoke. Ammonium chloride, ammonium carbonate, and copper sulfate all changed for.

3. How can heating substances help you to identify them?
Every substance changes into different phases at different heat temperatures which makes it easier to identify when each material changes different at the same temp. Substances react differently to different temps.

Thermal decomposition - when heat is used to reduce a chemical to something simpler.
Emergency lesson 1: How to complete labs

Duquesne Intern
November 23 and 24, 2009

Subject: Science  Unit: Chemistry  Level: 8  Sections: 9, 10, 11, 12

I. Targets

Students will be able to:

- List and follow the four important rules for properly completing lab activities.
- Review and correct their density labs.

II. Materials

I will utilize the following materials:

- Overhead projector, transparencies, and transparency markers
- Density lab transparencies
- Four important lab rules transparency

IV. Procedure

- Before advisor time
  - Move overhead into place and test it
  - Have all labs graded and arranged by lab group
- During advisor time
  - Greet students at the door
  - Tell them to sit in their lab groups
  - Explain why we will use advisor time to review the labs
  - Pass out labs and let students silently look over their labs for five minutes
  - Ask students to identify why they missed the majority of their points
  - Tell students to get out a sheet of paper
    - Title the paper “4 rules for completing labs”
    - Present and discuss the importance of each rule
      - Always include proper units with every answer
      - Always read and follow directions accurately and completely
      - Always use complete sentences
      - Always finish every section
    - When discussing each rule show examples in the density lab where the rules were broken
  - Tell students to place this sheet in their notebooks
- Review the rest of the lab
- Ask students to make suggestions as to how the labs could be improved
- Announce that everyone will receive 10 out of 10 points for completing the lab and the lab review
- Explain that students are now expected to follow the four major rules

V. Assessment

I will assess my students in the following ways:

- I will determine if my students follow the four major lab rules by observing them in class and by reviewing future labs.
Lesson 18: Phase change lab

Subject: Science  Unit: Chemistry  Level: 8  Sections: 9, 10, 11, 12

I. Targets

Students will be able to:

- identify and safely use various laboratory equipment.
- induce, observe, and describe phase changes.
- create and explain their own phase change diagrams.

II. Standards

This lesson will focus on the following Pennsylvania state standards:

- 3.2.10.B: Apply process knowledge and organize scientific and technological phenomena in varied ways.
- 3.4.10.A: Explain concepts about the structure and properties of matter.
- 3.4.10.B: Analyze energy sources and transfers of heat.
- 3.7.10.A: Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions.
- 3.7.10.B: Apply appropriate instruments and apparatus to examine a variety of objects and processes.

III. Materials

I will utilize the following materials:

- Overhead projector, transparencies, and transparency markers
- Phase change lab packets (120 packets)
- Phase change packet overheads
- 7 bins with the following contents (day 1):
  - 2 test tubes
  - Test tube holder
  - 400mL beaker
  - Sheet of filter paper
  - Glass funnel
  - Safety goggles (4)
  - Safety aprons (4)
IV. Procedure – Day 1

- Before class
  - Move overhead into place and test it
  - Place lab packets on the back table
  - Make sure all gas jets are closed and gas is off
  - Create lab bins and place them at appropriate lab stations
  - Set broken glass receptacle on the front table
  - Set up the lab on the demonstration table for directions
  - Set out extras of all lab equipment on the front table
  - Create an overhead that says the following:
    - Get a yellow lab packet
    - Review the steps of part 1
    - Look for the underlined sections
  - Create an overhead that says the following:
    - Person A: Cleanup materials
    - Person B: Return materials
    - Person C: Retrieve materials
    - Person D: Restock materials/fold lab aprons
    - Persons A and B: 1st half of sulfur lab
    - Persons C and D: 2nd half of sulfur lab

- During class
  - Greet students at the door
  - Direct them to the opening activity
  - Gain attention
    - During your research last week, you read about phase changes. You acquired the necessary terminology, and you learned about the
conditions surrounding each of the phase changes. Today, you are going to induce, observe, and describe those very phase changes.

- Provide a quick review
- Ask students to look at their labs
  - Have a volunteer read paragraph one under part 1 of the lab
  - Pull out a sample of sulfur and talk about its use in everyday life (gun powder, fireworks, lead acid batteries, and fertilizers)
  - Reiterate how it is useful for demonstrating phase changes
- Review the steps of the lab
  - Remind students how to set up the Bunsen burners
  - Quickly demonstrate each step (draw attention to test tube safety)
  - Draw students' attention to the underlined and circled sections of the lab
    - These sections are here to draw your attention to the directions so that you complete everything thoroughly
    - Have students go back over these sections with their own pens and highlighters
  - Display overhead with student jobs and review them
  - Answer any questions
- Turn on the gas, announce this to the class, and let students begin the lab
  - Walk around and observe and answer questions
  - Help students with their Bunsen burners
  - Make sure students are not overly heating the sulfur
  - Make sure students finish their drawings and their observations
- Cleanup
  - Look for students working on their third set of drawings and observations
  - At this point, ask person A to begin cleaning
  - As the rest of the group finishes the observations, ask them to help the cleaning process
- Once all bins are back in their proper places, have all groups sit down
  - Ask person D to get any replacement equipment for their bins at the front of the classroom (new filter paper and test tubes when necessary)
  - Remind groups of homework: finish conclusions, read pg. 61 to 63 on asbestos
  - Ask students summary questions

V. Procedure – Day 2

- Before class
  - Move overhead into place and test it
  - Create lab bins and place them at appropriate lab stations
  - Make sure all gas jets are closed and gas is off
  - Set broken glass receptacle on the front table
- Set up the lab on the demonstration table for directions
- Set out extras of all lab equipment on the front table
- Create an overhead that says the following:
  - Get out homework
  - Get out lined paper and answer:
    - Why does it take so long to boil water?
    - What is the relationship between temperature and phase changes?
- Create an overhead that says the following:
  - Person A: Read the temperatures/stir
  - Person B: Retrieve materials/record time and temperature
  - Person C: Record time and temperature
  - Person D: Cleanup materials/Record observations

- During class
  - Greet students at the door
  - Direct them to the opening activity
  - Gain attention
    - Check and review homework
    - Discuss opening questions
    - Collect answers
    - Ask: What could we do to investigate the relationship between temperature and phase change?
    - Let students offer design ideas
  - Ask students to get out their books and turn to page 66
    - Review the steps of the lab and demonstrate them at the front table
    - Display and discuss student jobs
    - Ask if there are any questions
  - Tell groups to setup the lab first using empty beakers
    - Once they are all setup, have person B come to the front to have their beakers filled with ice and water (50mL of water, add ice to 150mL)
    - Have them return to their groups to place the beaker on the tripod
    - Place thermometers into the ice water
      - Once every thermometer reads 0°C, have students read 0°C for 2 minutes every 30 seconds
      - Explain that the teacher will announce the time every 30 seconds, at which point they are to record the temperature and observations and stir their ice water
    - Turn on gas and announce this to class
    - Have groups light their Bunsen burners outside of their tripods
      - Check to make sure every flame is the correct heat and height
      - Have everyone push their Bunsen burners under their tripods at the same time
    - Once a group maintains boiling temperature for 2 minutes they are to shut off their Bunsen burner and call Mr. C. over