What "Wood" the Density Be?

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OVERVIEW: Mass, volume, and density. This lesson will allow students to manipulate different objects to determine density. They will use an interactive website that allows them to find the density after they have found the mass and volume. Then the students will see if the object will sink or float. Also, students will find the density of different wooden blocks by measuring the mass and volume. The wooden blocks will be of different sizes and kinds of wood. The data that the students gather from finding the density of the different woods will be recorded and then entered in the graphing calculator, where they will graph the data in a scatter plot graph. They will compare the densities of the different woods and will try to match the densities with the types of wood when given the kind of wood each is.

GRADE LEVELS: 6^{th} – 8^{th} grade

TIME ALLOTMENT: 3 – 45 minute blocks

SUBJECT MATTER: Science

LEARNING OBJECTIVES:

Students will be able to:

- gather data using electronic balances and metric rulers to gather data.
- store and graph the density calculated by using a graphing calculator.
- find mass, volume, and density using an interactive Web site and determine it an object will sink or float.
- define/differential and describe the relationship between mass, volume, and density.
- measure mass, volume and density using the metric system.
- explain the relationship between the density of the objects (whether they sink or float) and the density of the water.

STANDARDS:
State Standards:
The objectives listed may be used in part to address the Virginia Standards of Learning at http://pen.k12.va.us

- The student will successfully use triple-beam and electronic balances, metrics rulers, and graduated cylinders to gather data (VA. SOL Science PS.1, LS.1, 6.1. Math 6.1)
- The student will accurately measure volume, mass, and density using the metric system (VA. SOL Science PS.1, PS.2, 6.1. Math 6.10, 7.9, 7.10)
- The student will use graphing calculators to store, organize, and graph data collected (VA SOL Computer/Technology A.1)
- The student will identify scatter plots on a graphing calculator (VA SOL Math 7.20, 8.13, 8.18, A.17, A.18)
- The student will use wide-area networks and modem-delivered services to access and retrieve information from electronic databases (VA. SOL Computer/Technology C/T8.4)

MEDIA COMPONENTS:

Video:
Eureka, #126, ***Buoyancy***

Web Sites:
Density Shockwave Lab Simulation
(Mass, Volume, Density: Floating Lab)
http://www.temos.net/Science/physics.htm
At this site, students can manipulate the objects given. They can find the mass of the objects on an electronic balance and the volume using a graduated cylinder. They will find the density by dividing the mass by the volume. After predicting if the object will sink or float, the student will place the object into a container of water.

MATERIALS:

Materials needed for Introductory Activity: (for teacher)
- 1 light tube (found at Lowe's)
- 1 1 ¼ in. PVC pipe cap
- 600 mL of water
- 70 mL of table salt
- 3 beakers (200 ml or greater)
- 1 drop of blue food coloring
- 2 drops of red food coloring
- 2 stir sticks
- cement glue

Materials needed for Learning Activity for each group of two or students:

- Computer
- One copy of Density on the Internet Worksheet (Can be downloaded from the website given above in lesson)
- Graphing Calculator
- Pencil

Materials needed for Culminating Activity for each group of two or three students:

- 1 Graphing Calculator
- T1 Viewscreen
- 5 wooden blocks (different size and different kinds of wood: example: pine, oak, maple, poplar, walnut, etc.)
- triple-beam balance or electronic balance
- 1 metric ruler
- One copy of the Data Recording Sheet
- Pencil

PREPARATION FOR TEACHERS:

- ✓ Prior to teaching the unit, bookmark the Web sites.
- ✓ Have your videotape cued to Volume and Density.
- ✓ Photocopy all student handouts for distribution as needed during the lesson.
- ✓ Have the wooden blocks numbered 1 to 20 (or however many blocks of wood you have.)
- ✓ Make sure you go through the instructions from the student materials handouts to make certain that you understand and are familiar with the lesson format and what the students need to do or understand for the lesson.
- ✓ When using media, always provide the students with a Focus for Media Interaction, which is a specific task to complete during or after viewing video segments, Web sites, or other media material.
- ✓ Prior to this lesson, students should have used and accurately measure objects using the balances, metric rulers, and graduated cylinders.

INTRODUCTORY ACTIVITY: SETTING THE STAGE

Prepare the light tube (turbidity tube) before the lesson. Using cement glue, glue the PVC pipe end to the light tube. (Make sure it doesn't leak.)

Tell students that to start this activity we need to do some mixing. Get a volunteer to mix the first ingredients.

1. Have a student prepare in one beaker, 200 mL of water and 1 drop of blue food coloring. Add 45mL of table salt and stir for about 3 minutes until the salt is dissolved. Ask, " Is all the salt dissolved? If not, stir it another minute."

2. Get another volunteer. Have another student prepare in another beaker, 200 mL of water and 2 drops of red food coloring. Add 20 mL of table salt and stir for about 3 minutes until dissolved.
3. Have another beaker with 200 mL of water without color or salt.
4. Tell the students that you are going to pour the different water solutions into the tube. Ask: "What do you think will happen?" (Accept any reasonable answer, but ask why each gave that answer.)
5. Tilt the tube to about 45^{o} and slowly pour the salt and water solution with the green food coloring in first. Then, slowly pour the salt and water solution with the red food coloring in next. Last, slowly pour the water without salt or coloring into the tube. (The more salt that is dissolved in the water, the more dense the solution. The blue salt water solution should be at the bottom and the red salt water solution should be in the middle with the clear solution on top. The solutions will mix if stirred and after a time they will mix due to an area of high concentration going to an area of low concentration.)
6. Ask, "What happened?" (The water with the most salt stayed at the bottom and the water with no salt stayed at the top.) "Why?" (The more salt that the solution has, the more dense the solution.) "Did the different colors make any difference?" (No) "Which is more dense, salt water or fresh water?" (Salt water is more dense.) "How could we prove this?" (We could find the density or the salt water and compare it to the density of the fresh water.) "What do you think happens when a river flows into the ocean?" (The fresh water will flow on the top for a time.)

LEARNING ACTIVITIES

1. Provide the students with a **Focus for Media Interaction**, and say, "Students, I'm going to show you a segment of a video on mass, volume and density. We will find out what they are and how they are related. To begin, I want you to watch the video to see what kind of problem the Junk Car Dealer has and what he needs to know to solve his problem." **Start** the video when you see the words "Volume and Density" at the beginning and **Pause** when you **hear: "**How small should you crush the container?" and **see** the purple car crusher and Junk Car Dealer tapping his foot. Ask: "What kind of problem does the Junk Car Dealer have? (His cars will not fit into his container.) What does he need to know to solve his problem? (He needs to find out how he can get his cars in the container.) How do you think he will solve his problem? (He will crush the cars.)"

2. **Focus for Media Interaction:** Say, "Before he can shrink his cars he has to do something to his container. I want you to watch and tell me what he does do to his container and how he does this." **Resume** video and **Pause** when you **hear:** "How much space is inside the container?" and **see** the Junk Car Dealer inside his container trying to measure the inside. Ask: "What is the Junk Car Dealer going to have to do to his container?" (He needs to find out the size of his container.) "How will he find the size of his container?" (He will measure it.) "Why doesn't he just crush them up in any size?" (The cars still might not fit in the container.) "Is knowing the size of his

container important?" (Yes) "Why?" (He needs to crush the cars so that he can get all of them in the container.)

3. **Focus for Media Interaction**: Say, "Next, I want you to see how he finds the size of his container. Listen for the word that tells how much space his container holds. When you hear the word (volume) raise your hand. This way I will know that you heard the word" **Resume** the video and **Pause** when you **hear**: "But what does all this got to do with density?" and **see** the Junk Car Dealer jumping excitedly after the crushed cars have been put into the container. Ask, "What word did you hear that tells the amount of space his container holds?" (volume) "How does he the Junk Car Dealer find the size of his container?" (He measures it.) "What formula or rule did he use?" (L x W x H) "How many cars did he have and how small did he have to crush them?" (He had 8 cars. The cars were crushed into 2cm x 2cm x 2cm cubes or $2cm^3$) "Does anyone remember what the volume means?" (The word volume means "envelop".)

4. **Focus for Media Interaction**: Say, "Now we've found out about volume but what does it have to do with density? I want you to also listen for what mass has to do with density. See if you hear what density means in the video. When you hear what it means, raise your hand again." **Resume** video once more, and **Pause** when you **hear:** "And now you know the meanings of volume and density" and **see** the Junk Car Dealer is under the hook that lifts the cars. Ask, "What does the word density mean?"(compact) "Can you remember what the word "volume" means?" (envelop) "How is mass related to density?" (You have to know the mass before you can find the density.) "How did they find density?" (They found the mass and the volume.) "What formula did they use?" (Density = mass / volume)

5. **Focus for Media Interaction**: Say, "We heard that there were ways to increase density. How many ways did they say that we could increase density? And what are the ways that density can be increased? I'm going to rewind and let you listen and watch one more time in case you missed the ways that density was increased." **Rewind**: Where you see the 2000 kg car being crushed. **Play** and **Stop** when you **hear**: "How dense can you get?" and **see** the Junk Car Dealer is crushed into a cube. Ask, " How many ways can we increase density?" (two) "What are the two ways stated in the video?" (Volume stays the same and you increase the mass, or the mass stays the same and you decrease the volume.)

6. **Focus for Media Interaction**: Say, "We have learned that we have to find the volume and mass in order to find the density. What is the formula that we need to use? (Density = mass / volume) I am going to pass out a worksheet for density that I want you to fill out as you work at a website on density. You may use a calculator to do the math. Be sure to use the correct units and answer the questions at the bottom. When you are finished, turn this paper in for evaluation."
   Note to teacher: Have the Web sites bookmarked on the computers to be used by the class. Students may work individually or in groups of two.

7. Pass out the *Density on the Internet* worksheet (See attached worksheet.) and go over the worksheet with the students. Then allow the students to go to the computer and complete this activity.

CULMINATING ACTIVITY

This activity emphasizes gathering data and graphing the data on a graphing calculator. This hands-on activity allows students to measure and find volume, mass and density. They will then record data in the calculator and will graph a scatter plot.

1. Say, "You are going to be given 5 wooden blocks and on each block you will notice a number. Be sure to record the data with the correct number. I will also give you a Data Collecting Sheet, a calculator, and a metric ruler. I want you to find the volume of each wooden block. Record this measurement in the correct column of the Data Recording Sheet (See attached worksheet). You will then find the mass of each block and will record these measurements in the correct column. Then I want you to use the formula for density and find the density of each block of wood. I want to remind you to be as accurate in your measuring as you can be. This is very important."

2. Pass out the Data Recording Sheet to each group and allow one student from each group to collect the materials needed.

3. After everyone has finished collecting their data, tell the student, "We are getting ready to use the graphing calculators to graph our densities that we have found." (Have your T1 Viewscreen on an overhead projector and your graphing calculator attached so you may lead your students through the process.)

4. Say, " We are now going to record the data in our calculators" (If you have enough calculators for each student, let each student graph the data.) "We will now get our calculators ready for our data. Press the key "**on**". Press "**mode**", making sure all highlighted areas are on the left side. Press "**2nd,**" and "**zoom**", making sure all highlighted areas are on the left side. Press "**2nd,**" and "**stat plot**" and go to number 4 and press "**enter**". Press "**enter**" again and you will see the word "Done". Press "***Y*=**" and make sure all is cleared. If not press "**clear**".

5. "Now press "**stat**" and enter on number 1:Edit. (Make sure that L1 and L2 are cleared. If not, clear the lists by moving cursor up until it is blinking on L1. Press "**Clea**r" and enter." Do the same for L2.) In L1, enter 1, 2, 3, 4, etc. until the number is equal to the number of wooden blocks that the class has measured. (You will enter after each number is written.)

6. In L2, enter the density of each wooden block, starting with #1, #2, #3, etc. until all the densities have been recorded in L2. Now, press "**2nd,**" and "**stat plot**." Press "**enter**" two times. Bring the cursor to the first graph shown on the screen and enter. Make sure that the L1 is on the Xlist and the L2 is on the Ylist. Bring the cursor down to "**mark**" and enter on the dot.

7. Next, press "**zoom**" and arrow down to number 9 and press enter. This will give you the window that you need for your graph. Now press "**graph**". Press "**trace**" and move the cursor to the right and left in order to view the values. Discuss the scatter plot.

8. To put the list in ascending order, press "**stat**" and enter on 2:SortA(. You will see on the screen "SortA(. Now press "2nd" and 2 for L2. Press the) key to enclose L2. Press "**stat**" and "**enter**" on 1:Edit.You can see the values are ascending order. Have a student(s) place the objects in order on the table or counter from least to greatest value in terms of density. (Try to get the student(s) to group like wood with like wood.)

9. Now press "**graph**" to see the difference in this graph and the first graph. Then discuss the differences in the density of the different woods. Ask, "Will the wooden blocks float? (Yes) "Why"? (Their density is less than the density of water.) "Do you think you might match the groups of wooden blocks with the names of the kind of wood used?" Give the students the names of the 5 different kinds of wood used and let one student try to match the wooden blocks with the name and see if other students agree. If correct, talk about the hardness of wood in relationship to the density. If not, let another student try. Do this until it is correct.

ASSESSMENT

1) The Density on the Internet worksheet will be evaluated.
2) The Data Collecting Sheet will be evaluated.
3) A quiz will be given on finding density when given the volume and mass.

CROSS-CURRICULAR EXTENSIONS

Science:
Students can use the knowledge gained from this lesson to explain and investigate the buoyancy of object. Students can continue with finding density of liquids and irregularly shaped objects.

Social Studies:
Students can research the different kinds of wood and where they can be located. An example would be the redwood found in California. (Another example would be iron wood that cannot float.)
Students could study population density.

Math:
Students can take the data collected and find the mean, median and mode. They could graph the data using the box-and-whiskers graph. They can also find the first and third quartile and the maximum and minimum values.

Language Arts:
Students can write a descriptive paragraph describing each step that was taken to find the density of the wooden blocks and explain how these densities can be compared to water's density.

COMMUNITY CONNECTIONS

- ✶ Invite a physical therapist to the classroom and have the therapist discuss with the class how he/she uses volume in therapy.
- ✶ Invite an EPA person to the classroom to discuss how animal life is affected by materials with different densities that are dumped into streams and waterways.
- ✶ Other websites that may be used are:

Density Calculations

http://dbhs.wvusd.k12.ca.us/SigFigs/Density.html

At this site, students can learn how density is calculated. There are Practice Problems on density.

Density, Mass and Volume

http://science.widner.edu/svb/tutorial/density.htm

Here, the students can practice their density, mass, and volume calculations. They can enter their answers and check if correct. If incorrect, the students can try again.

The Physics of Density

http://www.sciencejoywagon.com/physicszone/lesson/00genral/density.html

At this site, density is described. Common units are given for density. Examples of superposition are given and objects that change density.

Density on the Internet

Name: _____ Date:_____ Period:_____

Description	Mass (g)	Volume (mL)	Density (g/mL)	Does it float?	Rank
Blue Square					
Blue Triangle					
Red Square					
Red Oval					
Pink Square					
Purple Oval					
Green Triangle					
Grey Triangle					
Tan Rectangle					
Red/Black Rectangle					

What is the density of the liquid in the pan? _____

Find the mass and volume of the objects. Calculate the density of the objects (mass divided by volume). Write "YES" if the object floats, and "NO" if the object does not float. Rank: Number the objects from lowest density to highest density.

Questions:

1.) Do you notice any pattern between the density of an object and the ability of the object to sink of float? If so, what is the pattern?

2.) Which object has the greatest volume? _____ the least? _____

3.) Which object has the greatest mass? _____ the least? _____

4.) Which object has the greatest density? _____ the least? _____

Name: _____

DATA RECORDING SHEET

Number of Wooden Block	Mass (g)	Volume (cm^3)	Density (g/cm^3)

1. What unit did you use for finding mass? _____
2. What unit did you use for finding volume? _____
3. What unit did you use for finding density?_____
4. Which wooden block had the most density? _____
5. What is the density of water? _____
6. Would the wooden block sink or float in water? _____ Why? _____ _____
7. What would the density of the wooden block have to be in order to sink? _____
8. What formula did you use to find the volume? _____
9. What formula did you use to find the density? _____

ANSWER KEY

1. grams
2. cubic centimeters (cm^3)
3. grams/cubic centimeters (g/cm^3)
4. (This answer will depend upon the type of wood used.)
5. 1.0 g/mL
6. Float ; The wooden blocks are less dense than water.
7. The wooden blocks would have to have a density greater than 1.0 g/mL.
8. V = L x W x H
9. Density = mass / volume