4TH GRADE
MEASURING MASS AND VOLUME

Summary: Students compare the density of three different materials. They measure the volume of their objects with a ruler and through water displacement. Mass is determined by using a balance. Students observe that objects with a larger mass per volume ratio have a higher density and objects with a smaller mass per volume ratio have a lower density.

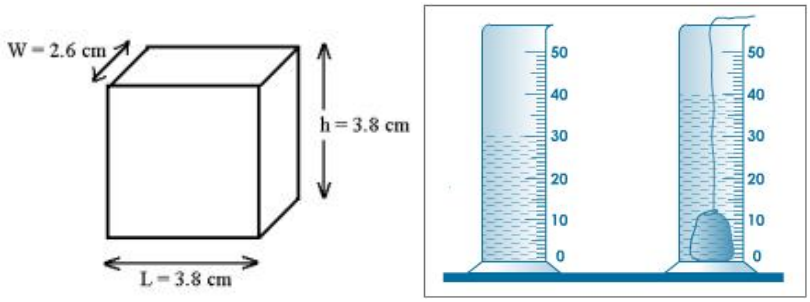
Intended Learning Outcomes for 4th Grade:
1a. Observe simple objects and patterns and report their observations.
1d. Compare things and events.
1e. Use instruments to measure length, temperature, volume, and weight using appropriate units.
1f. Conduct simple investigations when given directions.
1h. Use observations to construct a reasonable explanation.
4a. Record data accurately when given the appropriate form and format.

Preparation time: 40 min
Lesson time: 1 hour
Small group size: Works best with one adult for every 6 students.

Materials: There is a 20% discount from enasco.com for Utah educators. The code number is 10130.
1. 1 set of 18 Density Blocks from enasco.com. SB45749M $33.50. This lab requires three objects that have dimensions in whole number centimeter units. Many cubes are in inches, which won't give you a whole number when the volume is measured in milliliters. If you school has something like this available then you don't need to use these exact ones. These 18 blocks will be enough for 6 groups of students each using 3 blocks.
2. A balance and gram mass cubes. (Having one balance per group is ideal.) Gram mass cubes can be ordered from enasco.com TB16755M Set of 500 for $12.50.
3. 1 100 ml graduated cylinder for each group. (If you have three graduated cylinders per group that is ideal.) Enasco.com SA02307M $1.95 each if 6 are purchased.
4. 3 rulers per group
5. 2 plastic cups per group
6. The same brand of diet and regular soda that has been left open for 24 hours. Two cans of each are enough for one class.
7. 1 calculator per group
8. Tall thin jar filled with cooking oil and an ice cube.
9. Large see through bucket or aquarium filled with water.
10. 39 g of sugar in a Ziploc bag.

Background Information:

Volume measures how much space an object takes up. Volume can be measured in two ways. Regularly shaped objects can be measured with a ruler. Volume is calculated by multiplying length x width x height. The unit for volume is cm^3. We can measure irregularly shaped objects by seeing how much volume they displace in a graduated cylinder. The unit for volume measured in a graduated cylinder is milliliters. 1 ml = 1 cm^3 In this lab, students will measure the volume of three objects with a ruler and through water displacement. The three objects in the lab have the same volume. Therefore, students will observe that they achieve the same number whether measuring with a ruler or through water displacement.



Mass is the amount of substance an object has. Students will measure mass using a balance. The unit for mass is the gram. Mass differs from weight because in weight gravity has an effect on the value. When you find the mass of an object it negates gravity because gravity is the same on both sides of the balance.

Density measures the amount of mass in a particular volume. This can be calculated through the equation D=M/V. This is a difficult concept for this age of students. However, if students calculate different masses for objects that have the same volumes they can understand that a higher density is due to more mass per volume and vice versa. In this lab students will compare three objects that have identical volumes but very different masses. They will conclude that the object that has the most mass per volume has the highest density. Density is a constant for pure substances. The density of water is 1 g/1ml.

Diet Coke and regular Coke differ by how much sugar is in the soda. One can of Coke has about 39 g of sugar while one can of Diet Coke has no sugar and .1 g of sweetener. Only a small amount of sweetener makes Diet coke taste sweet while it takes a lot of sugar to make a regular Coke sweet. Therefore, a regular Coke has 39 more grams per can of soda. The 39 more grams packed into the same volume gives regular Coke a higher density than Diet Coke and pure water.

Pre-lab discussion and demonstration: Fill a tall, thin jar with cooking oil. Place an ice cube on top and watch as the ice melts. Observe and discuss how and why the melting ice cube water sinks to the bottom of the jar. Show students an aquarium filled with water, a Diet Coke, and regular Coke can. Make sure you try this experiment first because it doesn't always work as shown. Use these two examples to discuss with students and explain mass, volume and density. Other examples to use are: New York City is DENSELY populated because there are a lot of people in a small area. 20 people in an elevator are DENSER than 2 people in an elevator. Give students an overview of the definitions for volume, mass and density.

Instructional Procedure:

Experiment 1: Volume of a Solid Object – If purchasing the suggested density set, be sure and give the students in one group three materials that are all the same size. Give them either three objects that are 1 cm cubes, 2 cm cubes, or 3x2x1 blocks.

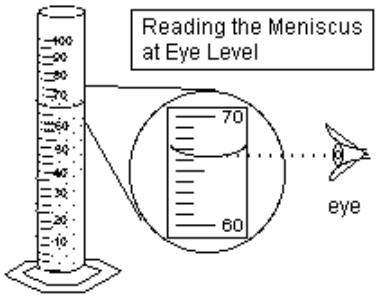
1. Have students compare the three objects at their table. Let them guess the materials and then tell them the names of the three materials they will test. Discuss how they are the same and how they are different. For example, the objects are all the same size but made of three different materials.

2. Measure the lengths, in centimeters, of the three sides of the three objects you are given. Be sure the students measure all 3 different sides without turning the block around and measuring one of the sides twice. Place these values of length, width and height on the data table.

3. Volume equals length x width x height. Help the students calculate the volumes of all three objects on a calculator. The unit will be cm^3 but that is a tough concept to explain to children. The volumes of the three objects are all the same.

4. Fill the graduated cylinder to 50 milliliters with water. Be sure that the bottom of the water level sits exactly on top of the 50 ml mark. You need to be

at eyelevel to the cylinder when you do this. This needs to be an accurate reading! Use a pipet or eyedropper to get the volume at exactly 50 ml.



5. Tilt the graduated cylinder and carefully slide in one of the solid objects. Be sure none of the water bounces out of the cylinder and that there are no air bubbles trapped near the object. Set the cylinder on the table and carefully read the new volume. Place the new volume on the table and subtract the initial volume from the final volume to find the volume of your object through water displacement. (This volume should equal the volume you obtained by multiplying length x width x height in the previous experiment.)

6. Repeat for the other two objects. The students should see that they get the same number for all three objects, whether it is measured with a ruler or through water displacement.

Experiment 2: Mass of a Solid Object

1. Have the students hold their objects in their hands and predict which has the least mass and which has the most mass.

2. Have the group who thinks they have the object with the least mass begin with the balance. They should place their object on one side of the balance and add 1-gram cubes to the other side until the two sides are as close to level as possible.

3. Count the cubes and place the number in the data table.

4. Have the other two groups repeat with their objects.

5. Discuss how the objects have the same volume but different masses. The material that has the lowest mass for its volume is said to have the lowest density. The material that has the highest mass for its volume is said to have the highest density.

Experiment 3: Comparing the density of three liquids. Be sure that the soda has been left open for 24 hours before the experiment. If the soda is very bubbly the calculations will be off. Careful measuring is very important in this experiment.

1. Place one plastic cup on each pan of the balance. The balance should be at a level point after this is done.

2. Have the students predict the order of density for water, regular soda and diet soda.

2. Using the graduated cylinder, carefully measure out 50 ml of water and place it into one of the cups. Try and be sure that all the drops of water are in the cup. Use gram cubes to find the mass of the water and place this value in the table. (The value should be very close to 50 grams because water has a density of 1 gram for every 1 ml.)

3. Dry the wet cup and make sure the balance is still level before you start the next sample. Use a dry graduated cylinder and repeat for the next two liquids. (Their masses won't be exactly 50 grams because they are not pure water.)

4. Discuss which liquid has the lowest density and which has the highest density.

5. Have students look at a Ziploc bag containing 39 g of sugar. Discuss why drinking regular soda is a poor health choice.