

ELEMENTARY SCIENCE PROGRAM
MATH, SCIENCE & TECHNOLOGY EDUCATION

A Collection of Learning Experiences

DENSITY

Density Student Activity Book

Revised July 2006



Name _____

This learning experience activity book is yours to keep. Please put your name on it now. This activity book should contain your observations of and results from your experiments.

When performing experiments, ask your teacher for any additional materials you may need.

TABLE OF CONTENTS

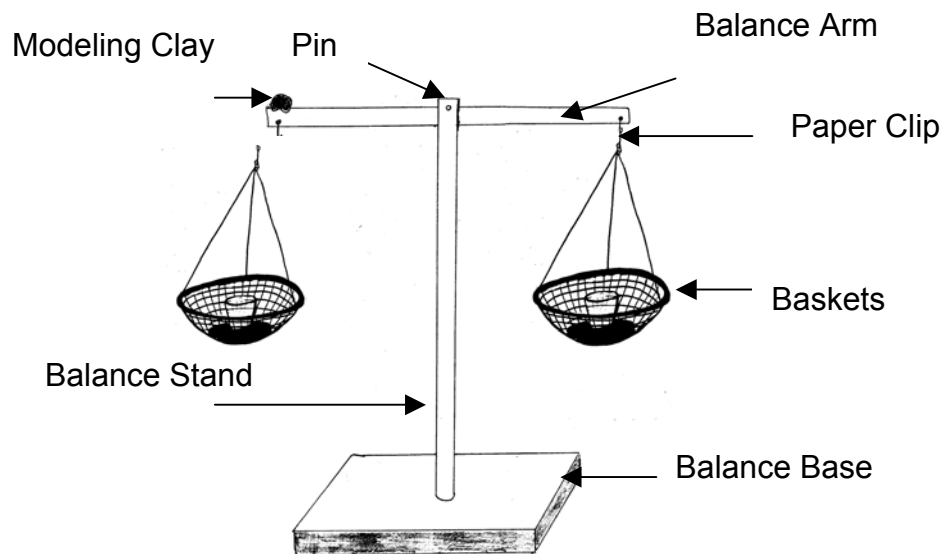
Activity Sheet for L.E. #2 - Measuring the Mass of Solid.....	2-3
Activity Sheet for L.E. #3 - Measuring the Mass of Unknown Liquids	4-5
Activity Sheet for L.E. #4 - Measuring The Volume of Solids	6
Activity Sheet for L.E. #4 - Measuring The Volume of Liquids and Using Liquids to Find the Volume of Some Solids	7-8
Activity Sheet for L.E. #5 - Density	9-10
Activity Sheet for L.E. #6 – The Density of Clay.....	11
Activity Sheet for L.E. #7 – Density Rainbow.....	12-13
Grade 4 Density Student Assessment.....	14-17
Grade 6 Density Student Assessment.....	18-21
Density Self Assessment.....	22
Glossary	23

MEASURING THE MASS OF SOLIDS

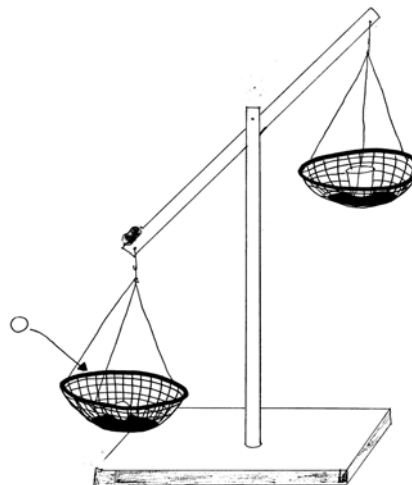
Everything you see and touch is **matter**. You are made of matter. The air you breathe is made of matter. So what is matter? Matter is anything that takes up space, and may have the observable properties that include color, texture, shape, volume and hardness. However, just because you might not be able to see all types of matter does not mean they are not there. Think of a balloon. If you pumped air into a balloon you would be able to see the volume of the air by the way it stretches and shapes the balloon. You cannot see air, but it is made of matter.

Mass is the amount of matter in an object, and it never changes regardless of whether you're here on earth or out in space. Mass is measured in the gram units (g). Large amounts of matter are measured in kilograms (kg). 1 kilogram is equal to 1000 grams. A balance is used to measure mass.

The picture below helps illustrate the proper way for constructing the double pan balance.



Measure the mass of each ball and arrange them in serial order from the smallest mass to the largest mass. **Note –The mass of similar balls might not be the same as those in other groups, but the serial order will be.**



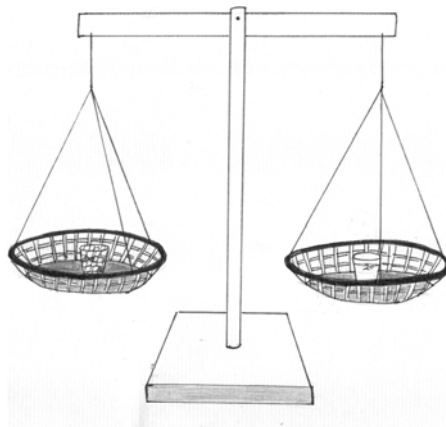
1. What is the mass of the super ball? _____ g
2. What is the mass of the black rubber ball? _____ g
3. What is the mass of the glass ball? _____ g
4. Order the balls from the smallest mass to the largest mass.
a. _____ b. _____ c. _____
5. Using scientific terms (including mass and matter), explain why you had different measurements for each ball.

MEASURING THE MASS OF UNKNOWN LIQUIDS

Water is an example of a liquid. Liquid matter has no definite shape, but it does have a definite volume. The mass of a liquid can be measured with a balance, just like a solid. Liquid volume is usually measured in milliliters, and solid volume is usually measured in cubic centimeters (cc), or cm^3 . 1 ml of water would exactly fill a 1cm cube.

Use these steps to measure the mass of three different liquids:

1. Get four medicine cups from your teacher. Find the 20 cc mark on each cup.
2. Pour red liquid into one medicine cup to the 20 cc mark if it is not already done for you.
3. Pour colorless liquid into another medicine cup to the 20 cc mark if it is not already done for you.
4. Pour yellow liquid into another medicine cup to the 20 cc mark if it is not already done for you.
5. Place an empty medicine cup in one basket of the balance.
6. Carefully place the cup with the red liquid into the other basket of the balance scale.
7. Add gram cubes to the empty medicine cup side of the balance scale until both sides are equal. Count the gram cubes to determine the mass of the red liquid. Record your data on the activity sheet.



8. Repeat steps 5 through 7 for the colorless liquid and yellow liquid.

Data:

1. What is the mass of the red liquid? _____ g
2. What is the mass of the colorless liquid? _____ g
3. What is the mass of the yellow liquid? _____ g
4. Order the liquids from the smallest mass to the largest mass.
1. _____ 2. _____ 3. _____

Questions:

1. Why do you think you had different measurements for each liquid? _____

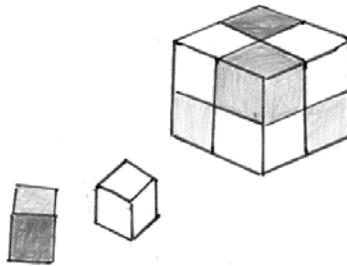
2. How did the masses of the liquids compare to the masses of the balls from Learning Experience #2? _____

3. Why did you have to be sure that all of the different liquids had the same volume of 20 cc? _____

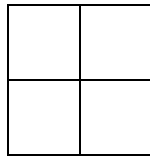
MEASURING THE VOLUME OF SOLIDS

Another way to measure matter is by determining its volume. Volume is a measurement of the amount of space an object takes up. It is measured in cubic centimeters (cc) or milliliters (ml). To find the volume of a regularly shaped solid, measure its length, width, and height and multiply them together. The units would be cc.

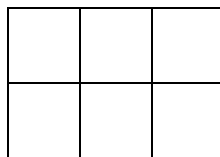
Measure a gram cube with a metric ruler. A single cube has a length of 1cm, a width of 1cm, and a height of 1cm. $1\text{cm} \times 1\text{cm} \times 1\text{cm} = 1\text{cm}^3$, or 1 cc. Now stack 8 cubes together to form a cube like in the diagram below.



1. What is the total volume you calculated for the larger cube? _____
2. How did you determine this volume? _____
3. Arrange the cubes as drawn in the diagram below. What is the volume? _____



4. Add 3 more layers to the structure. What would the volume be now? _____
5. Arrange the cubes as drawn in the diagram below. What is the volume? _____



6. Add 4 layers to the structure. What would the volume be now? _____

MEASURING THE VOLUME OF LIQUIDS AND USING LIQUIDS TO FIND THE VOLUME OF SOME SOLIDS

Liquids have no definite shape, so they take the shape of whatever container they are in. However, liquids do have a definite volume, which is measured in liters (L), or in smaller amounts, milliliters (mL). One liter equals 1000 milliliters. One milliliter (mL) is equal to one cubic centimeter (cc). Liquids are usually measured in a graduated cylinder or cup with graduated markings on it. The water level rises by the exact volume of the object. That amount is the object's volume.

It is important to note that when measuring the volume of a liquid, the person reading the volume must be eye-level with the liquid, or a false value will be obtained.

Liquids can be used to find the volume of a solid. Place an object into a known volume of liquid, then determine the new volume of the liquid with the object suspended in it. Subtract the new volume from the volume of the water alone and you will find the volume of the object alone. This is known as displacement.

1. Measure 20 cc of water in a medicine cup.
2. Place two sets of five gram cm cubes in the medicine cup. Note the change in the water level after each addition. What is the new volume of the water and the two sets of gram cubes? _____
3. Find the displacement by subtracting the original volume from the final volume. The formula has been provided:

$$\frac{\text{final volume}}{\text{final volume}} - \frac{\text{original volume}}{\text{original volume}} = \frac{\text{object's volume in cc}}{\text{object's volume in cc}}$$



4. What is the volume of the centimeter cubes in the medicine cup? (You can find the volume of the centimeter cubes by subtracting the original volume from the final volume). _____ cc
5. Repeats steps 1 through 3 using the super ball, black rubber ball, and the glass ball.



6. What is the volume of the super ball? _____ cc
7. What is the volume of the black rubber ball? _____ cc
8. What is the volume of the glass ball? _____ cc
9. Did your measurements of the volume of the different balls agree with other groups? _____
10. If there were differences, what reasons would you give to explain those differences? _____

DENSITY

Density is the measure of the “compactness” of a material. It is the ratio of mass to volume for any material. It is usually measured in grams per cubic centimeter (g/cc, g/cm³) and tells how much matter is packed into a given space. Density is not a simple comparison of the “heaviness” or “lightness” of materials. It is instead, a comparison of the “heaviness” or “lightness” of the same volume of material (mass per unit volume). The density of a material is determined by the masses of the atoms in the material and the amount of space between the atoms. Gases have a low density not only because the atoms making up the gases have a small mass, but also because there is a large amount of space between the atoms. The heavy metals like gold, lead, and uranium are very dense because the atoms they are composed of are massive and spaced closely together.

To calculate **density**, we divide the mass of the material in grams by its volume in cubic centimeters. We might just as well divide the mass in kilograms by the volume in liters, or the mass in metric tons by the volume in cubic meters, the answer in each case would be numerically the same. The density of an object equals its weight divided by its volume (D = M/V).

On the chart below, fill in the mass and volume of each ball from the previous learning experiences. Use the formula for density (Density = Mass/Volume or Mass ÷ Volume) and your calculator to find the density of the wooden ball and steel ball. Write your answers in the last column inside the chart below. (The formula is Density = Mass/Volume.)

	Mass	Volume	Density
Wooden Ball	g	cc	g/cm ³
Steel Ball	g	cc	g/cm ³

After calculating the mass, volume, and density of the wooden and steel balls, refer to Learning Experience #2 and Learning Experience #4 to fill-in the mass and volume of the super ball, black rubber ball, and glass ball in the chart below. Use the formula for density, Density = Mass/Volume, and your calculator to get the density of each ball.

	Mass	Volume	Density
Super Ball	g	cc	g/cm ³
Black Rubber Ball	g	cc	g/cm ³
Glass Ball	g	cc	g/cm ³

After calculating the mass, volume, and density of each of the solids, refer to Learning Experience #3 and Learning Experience #4 to fill-in the mass and volume of each of the liquids in the chart below. Use the formula for density, $\text{Density} = \text{Mass}/\text{Volume}$ and your calculator to calculate the density of each liquid.

	Mass	Volume	Density
Rubbing Alcohol	g	cc	g/cm^3
Water	g	cc	g/cm^3
Salt Water	g	cc	g/cm^3

Now that you have calculated the densities of the three balls, (glass, black rubber, and super) and the three liquids (water, rubbing alcohol, and salt water) serial order the densities beginning with the least dense.

Solids & Liquids	Density
1.	
2.	
3.	
4.	
5.	
6.	

Density as a Property That Remains Constant

Measure out a 25 gram piece of clay. Roll it into a ball. Use displacement to find its volume by placing it in a medicine cup filled with 20 cc of water. (You may have to flatten the ball slightly to completely cover it with water.)

1. What is the volume of the clayball?

$$\frac{\text{Volume of water with clayball}}{\text{Volume of water alone}} - \frac{\text{Volume of water alone}}{\text{Volume of water alone}} = \frac{\text{Volume of clayball}}{\text{Volume of water alone}} \text{ cc}$$

2. Find the density of the clayball. If the mass of clayball is 25 grams calculate its density. The formula has been provided:

$$\frac{\text{Mass of clayball}}{\text{Volume of clayball}} \div \frac{\text{Volume of clayball}}{\text{Volume of clayball}} = \frac{\text{Density of clayball}}{\text{Volume of clayball}} \text{ g/cm}^3$$

Cut the clayball in half using a plastic knife. Find the mass of half of the clayball and find the volume using displacement.

3. What is the volume of half of the clayball?

$$\frac{\text{Volume of water with } \frac{1}{2} \text{ clayball}}{\text{Volume of water alone}} - \frac{\text{Volume of water alone}}{\text{Volume of water alone}} = \frac{\text{Volume of } \frac{1}{2} \text{ clayball}}{\text{Volume of water alone}} \text{ cc}$$

4. What is the mass of the 1/2 clayball? _____ g

5. Find the density of the 1/2 clayball.

$$\frac{\text{Mass of } \frac{1}{2} \text{ clayball}}{\text{Volume of } \frac{1}{2} \text{ clayball}} \div \frac{\text{Volume of } \frac{1}{2} \text{ clayball}}{\text{Volume of } \frac{1}{2} \text{ clayball}} = \frac{\text{Density of } \frac{1}{2} \text{ clayball}}{\text{Volume of } \frac{1}{2} \text{ clayball}} \text{ g/cm}^3$$

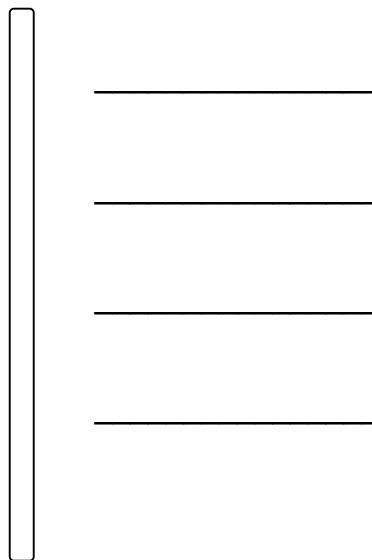
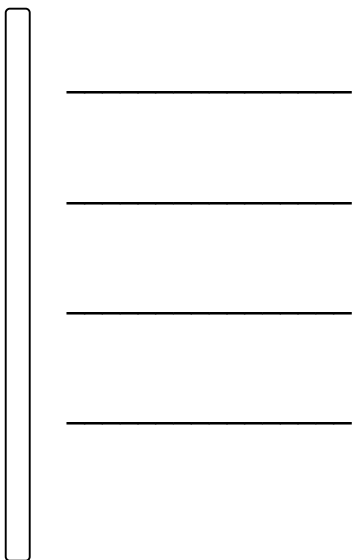
6. Are the densities of the clayball and the 1/2 clayball the same or different? If they are slightly different, what might account for those differences?

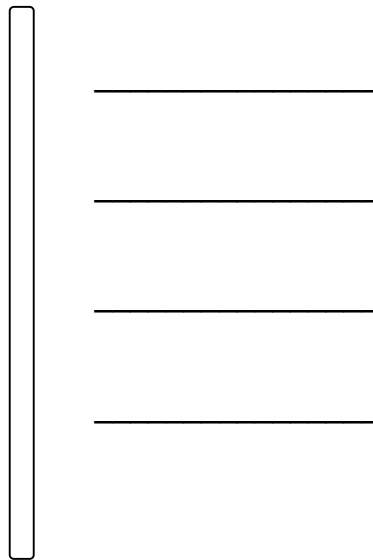
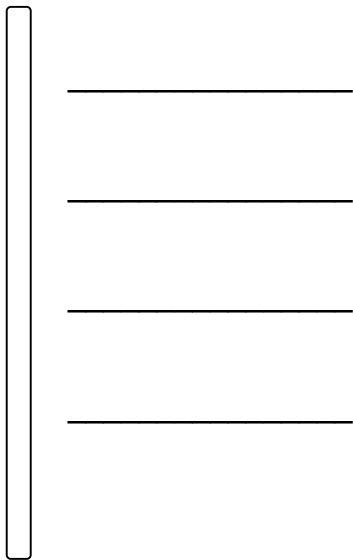
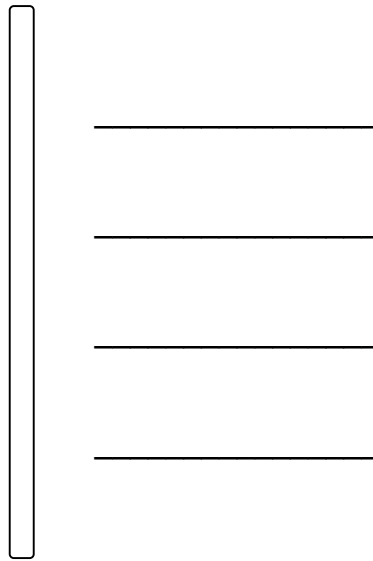
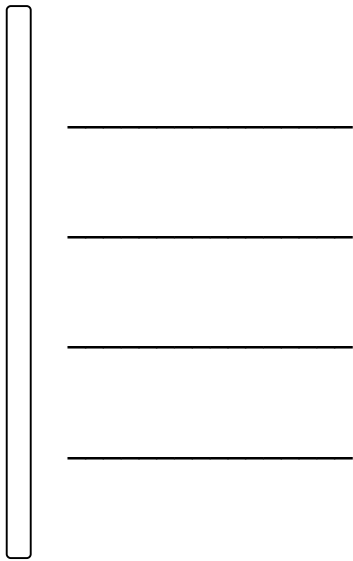
7. If you cut a clayball in half do the mass and volume both go down proportionally? _____

Density Rainbow

Serial Order is arranging items in a series of detailed plan for reaching a goal. Through a series of trial and error you are to find the serial order of 4 different colored liquids by arranging them from most dense to least dense.

1. Push a clear straw **at an angle** into a clay base.
2. Slowly add 5 to 10 drops of one of the colored liquids into the straw using a pipette. The liquids must go into the straw in a certain order for distinct layers to be seen.
3. Continue to add 5 to 10 drops of the second colored liquid into the straw using a pipette.
4. Continue doing this until all four different colored liquids have been added to the straw. Four distinct layers should be seen in the straw.
5. If the colors seem to mix instead of form layers empty your straw and start over. This time change the order in which you add the different colored liquids to the straw until four distinct layers are seen.
6. Record each step you do in the charts below. Start with the first liquid added to the straw – write the first letter of its color in the space provided (Y = yellow, R = red, B = blue, G = green). Repeat with the other liquids in the order they are added.





What is the final order of liquids from most dense to least dense?

_____ , _____ , _____ , _____

Grade 4 Assessment

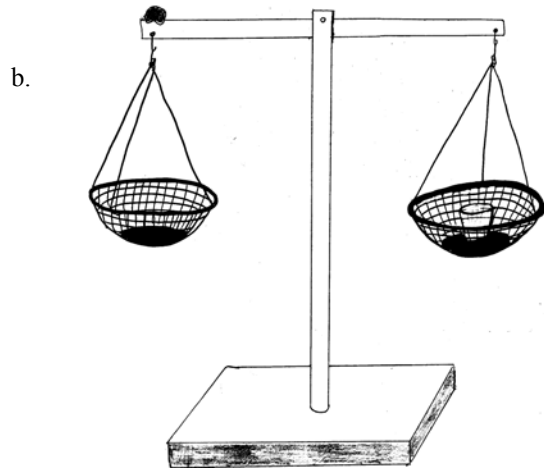
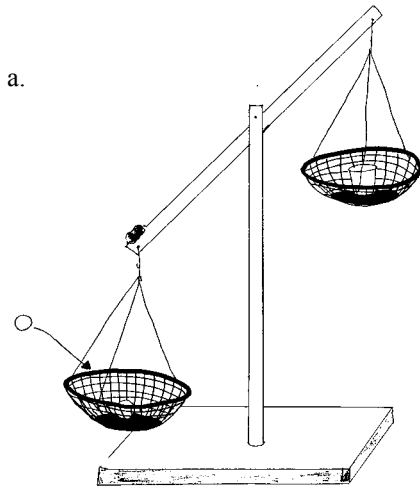
Name: _____
Grade 4 Density Student Assessment

Date: _____

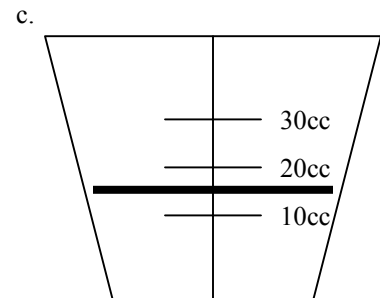
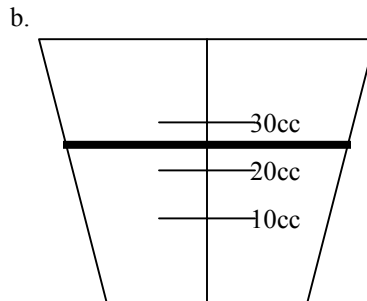
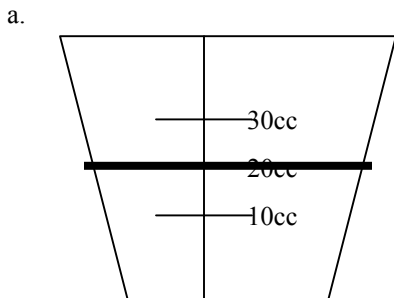
Density

Directions: Read the question carefully and answer based on your knowledge about density.

1. A student was asked to “calibrate” a double pan balance. Which picture accurately shows a calibrated balance?



2. A student was asked to measure 25 cc of liquid using a medicine cup. Which picture accurately shows 25 cc of liquid?



3. A student measured the mass of three same-sized balls: glass, black rubber ball, and a super ball. The following data table was recorded.

<u>Type of Ball</u>	<u>Mass (g)</u>
super ball	9
glass ball	18
black ball	10

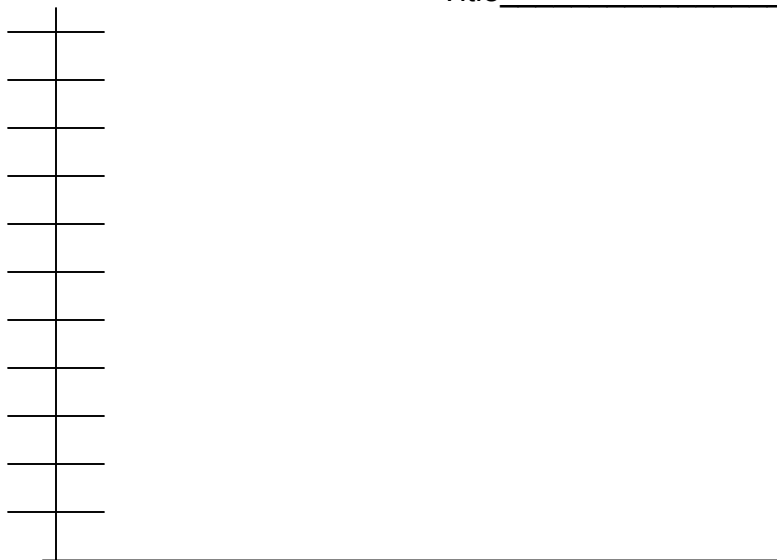
Why do you think the student obtained a different measurement for each ball?

4. A student measured the mass of five different types of liquids and recorded the data.

<u>Type of Liquid</u>	<u>Mass (g)</u>
Water	19
salt water	22
rubbing alcohol	15
blue solution	8
green solution	18

Construct a bar graph displaying the results.

Title _____



5. If you were to put all of the five liquids into a container, which one would raise to the surface? Which would be next? List them in order of placement on the chart.

6. Using eight centimeter cubes, construct two different designs. Carefully outline your design with a pencil, then complete questions 6 A-D.

DESIGN #1

DESIGN #2

6A. What is the volume of Design #1 ? _____ cc

6B. What is the volume of Design #2 ? _____ cc

6C. Based on your observations, what can you conclude about volume?

6D. What is volume? _____

7.) A student wanted to figure out the volume of a large marble. She measured out 20 cc of water in a medicine cup and then placed the enormous marble in the water. The results are shown.

Initial volume: 20 cc **Final volume:** 37 cc

What is the volume of the marble? _____ cc

How do you know that? Explain. _____

Vocabulary

Directions: Match the definition (letter) to the correct term (word).

- 1.) _____ Balance 2.)_____ Calibrate 3.)_____ Density
4.) _____ Displacement 5.) _____ Float 6.) _____ Mass
7.) _____ Serial order 8.) _____ Volume 9.) _____ Weight

- A.) to balance a scale or double pan balance
B.) the ratio of mass of an object to its volume/measure of “compactness” of a material
C.) objects that are less dense than water and overcome the force of gravity
D.) the amount of matter in an object
E.) an amount of space occupied by an object
F.) the measure of gravitational pull on an object
G.) an instrument for determining mass
H.) the amount of liquid pushed aside in a container by an object
I.) arranged “data” in some type of order

Grade 6 Assessment

Name: _____

Date: _____

Grade 6 Density Student Assessment

Directions: Read the question carefully and answer based on your knowledge about density.

1.) A student was asked to “calibrate” a double pan balance. Draw a picture to accurately show a calibrated balance.

2.) A student was asked to measure 25 cc of liquid using a medicine cup. Draw a picture that shows the proper measurement of 25 cc of liquid.

3.) A student measured the mass of three same-sized balls: glass, black rubber ball, and a super ball. The following data table was recorded.

<u>Type of Ball</u>	<u>Mass (g)</u>
super ball	9
glass ball	18
black ball	10

Why do you think the student obtained a different measurement for each ball?

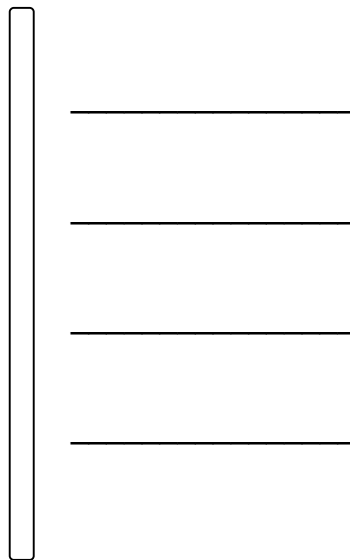
4.) A student layered 4 colored liquids into a plastic straw on a clay base. The 4 liquids contained varying amounts of salt.

	Mass (g)	Volume (cc)	Density (g/cm ³)
Plain water – blue	20	20	_____
Red water	23	20	_____
Green water	22	20	_____
Yellow water	21	20	_____

First, use a calculator and calculate the densities of all 4 liquids above. Remember

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

5.) If you were to layer all 4 of the liquids above into a straw from most dense to least dense, what order would the colors be in?



6.) A student wanted to figure out the volume of a ball of clay. She measured out 20cc of water in a medicine cup and then placed the clay in the water. The results are shown.

Initial volume: 20 cc **Final volume:** 30 cc

6A.) What is the volume of the clay ball? _____ cc

6B.) Show your work and explain why this is the volume of the clayball. _____

6C.) If you cut a 25g clay ball in half, what would you expect the mass, volume and density to be?

Mass of 1/2 of clay ball - _____ g

Volume of 1/2 of clay ball - _____ cc

Density of 1/2 of clay ball - _____ g/cm³

7.) **Vocabulary**

Directions: Match the definition (letter) to the correct term (word).

- | | | |
|------------------------|---------------------|-------------------|
| 1.) _____ Balance | 2.) _____ Calibrate | 3.) _____ Density |
| 4.) _____ Displacement | 5.) _____ Float | 6.) _____ Mass |
| 7.) _____ Serial order | 8.) _____ Volume | 9.) _____ Weight |

- A.) to balance a scale or double pan balance
- B.) the ratio of mass of an object to its volume/measure of “compactness” of A material
- C.) objects that are less dense than water and overcome the force of gravity
- D.) the amount of matter in an object
- E.) an amount of space occupied by an object
- F.) the measure of gravitational pull on an object
- G.) an instrument for determining mass
- H.) the amount of liquid pushed aside in a container by an object
- I.) arranged “data” in some type of order

8.) If the density of plain water is 1 g/cm³, write whether the following objects would sink or float in it:

		<u>Density</u>
_____	Copper Penny	= 8.9 g/cm ³
_____	Block of Wood	= 0.68 g/cm ³
_____	Vegetable Oil	= 0.93 g/cm ³
_____	Piece of Coal	= 1.20 g/cm ³

DENSITY
STUDENT SELF-ASSESSMENT



Name: _____

Date: _____

1. What do you now know about density that you didn't know before?

2. What do you know about displacement that you didn't know before?

3. How do you think you and your partner(s) worked together? Give some examples.

4. What learning experiences did you enjoy? Explain why did you liked them.

5. Were there any learning experiences in the unit you didn't understand or that confused you? Explain your answer.

6. Take another look at your activity sheets and science notebook. Describe how well you think you recorded your observations and ideas.

7. How did your work in this unit affect your attitude toward science?

GLOSSARY

Balance:	an instrument for determining mass by the equilibrium weights suspended from opposite ends of a horizontal bar.
Calibrate:	to divide with graduations of measurement.
Compare:	to examine for similarities and differences.
Contrast:	to compare to show differences.
Cubic centimeters:	a unit of linear measurement (centimeters) that is multiplied by itself twice to form a unit of measure for volume.
Density:	the ratio of mass of an object to its volume ($D=M/V$)
Displacement:	an object pushes aside (displaces) amount of liquid in a container by taking up the space the liquid once held.
Fair Test:	to conduct a scientific test where there are specific items that remain constant.
Float:	objects that are less dense than water that overcome the force of gravity.
Formula:	a rule expressed in algebraic symbols.
Level:	a horizontal position or condition.
Mass:	the amount of matter in an object (grams).
Plasticine:	a claylike substance.
Serial order:	arranged in a series of detailed plan for reaching a goal.
Volume:	an amount of space occupied by an object (cm^3).
Weight:	the measure of gravitational pull on an object.
Zeroing:	to aim at the exact center.