Name:_________________________ Period:______

Lab: Numbers in Science

Purpose: This activity will require you to use proper measurement techniques to collect data. Analysis of data will be done according to the rules for calculations with significant digits. Several examples of converting units with Dimensional Analysis will be performed. Error analyses will reveal specific aspects of measurement and calculation that affect experimental results.

****This lab must be done according to the rules for measuring and calculating with significant digits. All work must be shown to receive credit for calculations, and numerical answers must have units and must be properly rounded to the correct number of significant digits.****

Materials: cube, ruler/tape measure, 50 mL beaker, 100 mL graduated cylinder, electronic balance

Procedure: Remember when measuring to estimate a digit between the two smallest lines on the tool

1. Obtain a ruler, 50 mL beaker, and a 100 mL graduated cylinder. Record the increments and the uncertainty associated with each in the table below. **BE SURE TO RECORD THE CORRECT NUMBER OF SIG FIGS WHEN TAKING ALL MEASUREMENTS THROUGHOUT THE LAB!!!!!**
2. Mass the small cube on the balance and record your measurement on the data table.
3. Use the ruler to measure the dimensions (length, width, and height) of the cube in centimeters, being sure to use the full measurement capacity of the ruler (estimate!). Record these measurements in the data table.
4. Fill the beaker about halfway and record the initial volume of water. Carefully place the cube in the water and record the new, final volume of water.
5. Fill the graduated cylinder about three quarters full and record the initial volume of water. Carefully place the cube in the water and record the new, final volume of water.
6. Dry the cube with paper towels, pour any water into a waste beaker and return your materials.
7. Copy any relevant formulas and equivalences from the board onto your data table.

Measurement tools and Uncertainty:

Instrument	Smallest Increment	Estimated Decimal Place (Uncertainty)	Sample Reading
Ruler	.1cm	.01	2.54 cm
50 mL Beaker	10 mL	1 no decimal	12 mL
100 mL Graduated Cylinder	1 mL	.1	20.5 mL

mass should be btwn 5.00 - 5.50g
l, w, h measured w̄ ruler should be btwn 1.40 - 1.60 cm

Data Table

Watch your units! Watch your units!

Measurement & Unit	# SF	Measurement & Unit	# SF
Mass: 2 decimals		Length: 2 decimals	
Width: 2 decimals		Height: 2 decimals	
Beaker initial volume: no decimals		Beaker final volume: no decimals	
Cylinder initial volume: 1 decimal		Cylinder final volume: 1 decimal	

Formulas for Calculations

Volume of a cube = (l) x (w) x (h)

Density = mass/volume * Watch your units!

Equivalences for Dimensional Analysis **

1 ounce (oz) = 28.35 grams (g)	1 foot (ft) = 12 inches (in)
1 pound (lb) = 453.6 grams (g)	1 kilogram (kg) = 1000 grams (g)
1 milliliter (mL) = 1 centimeter (cm^3)	1 gram (g) = 1000 milligrams (mg)
1 inch (in) = 2.54 centimeters (cm)	**Don't consider the significant figures of these values when converting your measurements. Just round your answer so it has the same number of SigFig's as when you started.

*Must have shown all work for credit.

*sf = sig figs

Analysis (Final answers to be graded must go in the boxes):

*Don't forget units in all boxes

1. Begin by noting how many significant figures are in the measurements in the data table above.
2. Use dimensional analysis to convert the mass of the cube to:

   ex: 5400 has 2sf

   a. mg

   2 fractions in dimensional anal.
   if your mass ends in Ø you will have to put your answer in sci. notation for 3sf

   3sf

   b. ounces

   2 fractions in dim. anal

   answer should be less than 1

   round to 3 decimals

3. Calculate the volume of the cube in cm^3 using the volume formula.

   from ruler

   $V = l \times w \times h$

   round to 2 decimals

4. Use Dimensional analysis to convert the volume of the cube from cm^3 to m^3

   $cm^3 = cm \times cm \times cm$ use answer from #3

   needs 4 fractions in dim. analysis

   3sf

5. Calculate the volume of the cube in mL as measured in the beaker, then convert the volume from mL to cm^3 (show work for the volume calculation, but not the simple conversion).

   show subtraction

   $1 mL = 1 cm^3$

   no decimals

6. Calculate the volume of the cube in mL as measured in the graduated cylinder, then convert the volume from mL to cm^3 (show work for the volume calculation, but not the simple conversion).

   show subtraction

   $1 mL = 1 cm^3$

   round to 1 decimal

7. Calculate the density of the cube using its mass and its volume as measured by:

   a. the ruler

   $D = \frac{m}{V}$ ← from balance

   V from #3

   units must be consistent w/ mass & problem #3

   round to 2 decimals

   b. the beaker

   $D = \frac{m}{V}$

   V from #5

   round to 1 sf no decimals

   c. the graduated cylinder

   $D = \frac{m}{V}$

   V from #6

   2 sf

8. Use dimensional analysis to convert the density of the cube as measured by the graduated cylinder from g/cm^3 into kg/m^3

   2sf

   $cm^3 = cm \times cm \times cm$

   Dimensional analysis should have 5 fractions

Conclusion Questions:

1. Compare the densities of the cube when volume is measured by a ruler, by a beaker, and by a graduated cylinder. Which tool gave you the most precise density value? Use the concept of significant figures to explain your answer.

   When your calculations are done properly now, you should be able to see better which tool yields more precision AND you have to justify your choice w/ sig fig support.

2. A student first measures the volume of the cube by water displacement using the graduated cylinder. Next, the student measures the mass of the cube before drying it. How will this error affect the calculated density of the cube? Your answer should clearly state whether the calculated density will be too high, too low, or remain the same, and your answer must be justified.

   You cannot be vague. Do not use terms such as "affected" "inaccurate"

   Mass is not the same as weight, don't use weight.

   You must talk about what happens to the mass AND density & why.