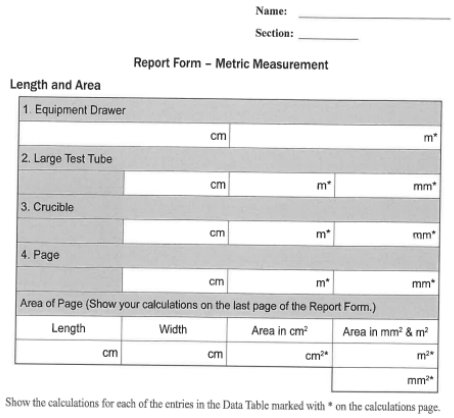
Chem 108: Lab

Week 4

Sign in: Roster @ front of lab

Pick up replacement page for today's experiment.

Last Week's Experiment:
Metric Measurement
Completed individual forms pp. 12-15
due today by the end of lab.



Name: _____

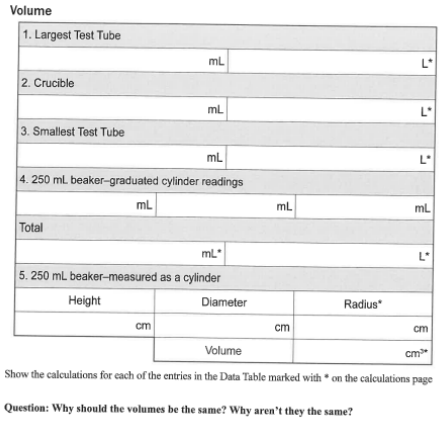
Section: _____

Report Form – Metric Measurement

Length and Area

1. Equipment Drawer			
	cm		m*
2. Large Test Tube			
	cm	m*	mm*
3. Crucible			
	cm	m*	mm*
4. Page			
	cm	m*	mm*
Area of Page (Show your calculations on the last page of the Report Form.)			
Length	Width	Area in cm^2	Area in mm^2 & m^2
cm	cm	cm^2*	m^2*
			mm^2*

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

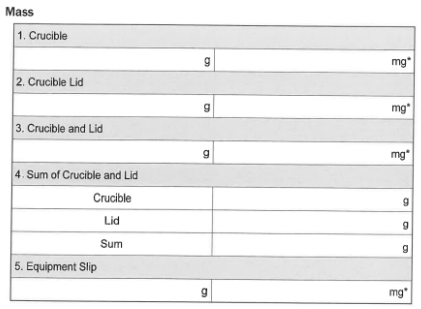


Volume

1. Largest Test Tube	
mL	L*
2. Crucible	
mL	L*
3. Smallest Test Tube	
mL	L*
4. 250 mL beaker–graduated cylinder readings	
mL	mL	mL
Total	
mL*	L*
5. 250 mL beaker–measured as a cylinder	
Height	Diameter	Radius*
cm	cm	cm
	Volume	cm^3*

Show the calculations for each of the entries in the Data Table marked with * on the calculations page

Question: Why should the volumes be the same? Why aren't they the same?



Mass

1. Crucible	
g	mg*
2. Crucible Lid	
g	mg*
3. Crucible and Lid	
g	mg*
4. Sum of Crucible and Lid	
Crucible	g
Lid	g
Sum	g
5. Equipment Slip	
g	mg*

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Include calculations. Staple together with partner's form and turn in before the end of lab.

Most legible report pages on top.

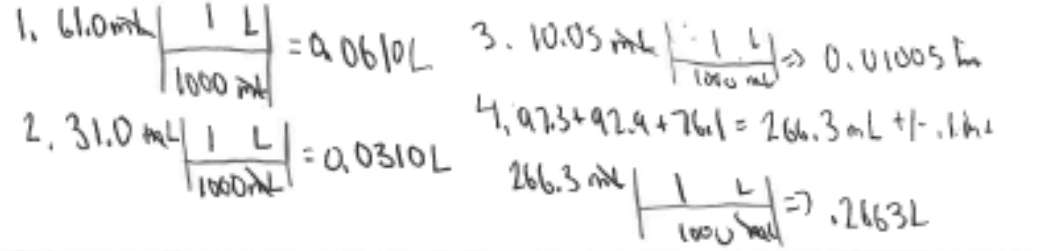
Exp. 1 – Metric Measurement

Example of an acceptable set of student data, conversions, and calculations. DO NOT COPY. ***Use as a guide.***

Volume

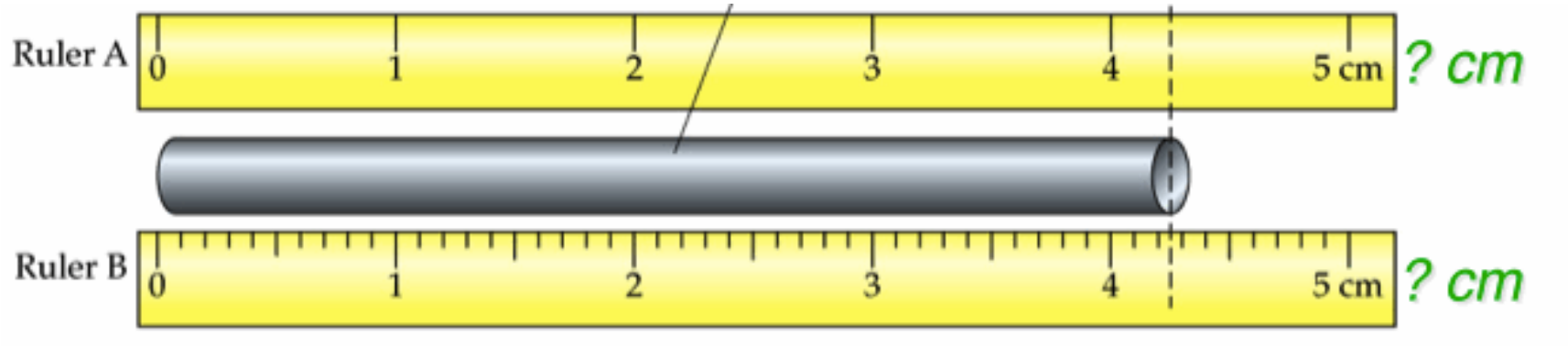
1. Largest Test Tube		
61.0 mL +/- 0.1 mL mL	0.0610 L +/- 0.0001 L	L*
2. Crucible		
31.0 mL +/- 0.1 mL mL	0.0310 L +/- 0.0001 L	L*
3. Smallest Test Tube		
10.05 mL +/- 0.01 mL mL	0.01005 L +/- 0.00001 L	L*
4. 250 mL beaker–graduated cylinder readings		
97.3 mL +/- 0.1 mL mL	92.9 mL +/- 0.1 mL mL	76.1 +/- 0.1 mL mL
Total		
266.3 mL +/- 0.1 mL mL*	.2663 L +/- 0.0001 L	L*
5. 250 mL beaker–measured as a cylinder		
Height	Diameter	Radius*
9.6 cm +/- 0.1 cm cm	7.0 cm +/- 0.1 cm cm	3.5 cm +/- 0.1 cm cm
	Volume	330.8 cm^3 +/- 0.1 cm^3

Show the calculations for each of the entries in the Data Table marked with * on the calculations page



Metric Measurement Conversions & Uncertainty

4.3 cm +/- 0.1cm



4.25 cm +/- 0.05cm

4.25 cm +/- 0.05cm = 0.0425 m +/- 0.0005 m

4.2 cm^2 +/- 0.1cm^2 = 4.2 cm^2 x 1m/100cm x 1m/100cm

= 0.00042m^2 +/- 0.00001 m^2

Adapted from *Workshop Chemistry*

Name(s): _____

Worksheet: Units, Measurements, & Conversions

https://www.youtube.com/watch?v=hQpQ0hxVNTg&list=PL8dPuuaLjXtPHzzYuWy6fYEaX9mQQ8oGr&index=2 (11:23 min/sec)

1. How many significant figures are there in the following numbers?

   a) 42,000. L _____ b) 0.4010 g _____

   c) 0.00130 s _____ d) 405,700,000 km _____

2. Complete the table. Provide ordinary decimal form or scientific notation and the type of unit. The first line has been completed as an example for **mass**.

Ordinary Decimal Form	Scientific Notation
0.683 kg (mass)	**6.83×10^{-1} kg**
1365 mL ( )	**mL**
( )	**1.034×10^{1} m**
0.00350 µs ( )	**µs**
( )	**1.75×10^{-3} cm^3**
1,605,000 nm ( )	**nm**

3. How many significant figures in the numeric value would be appropriate for each of the following values using the specified units?

   The speed of a car in miles per hour as read from a speedometer when traveling at the speed limit on Viking Drive (25 mph). ☐

   Your weight using lbs. ☐

4. Using your height in feet and inches convert to (a) centimeters (cm), and (b) meters

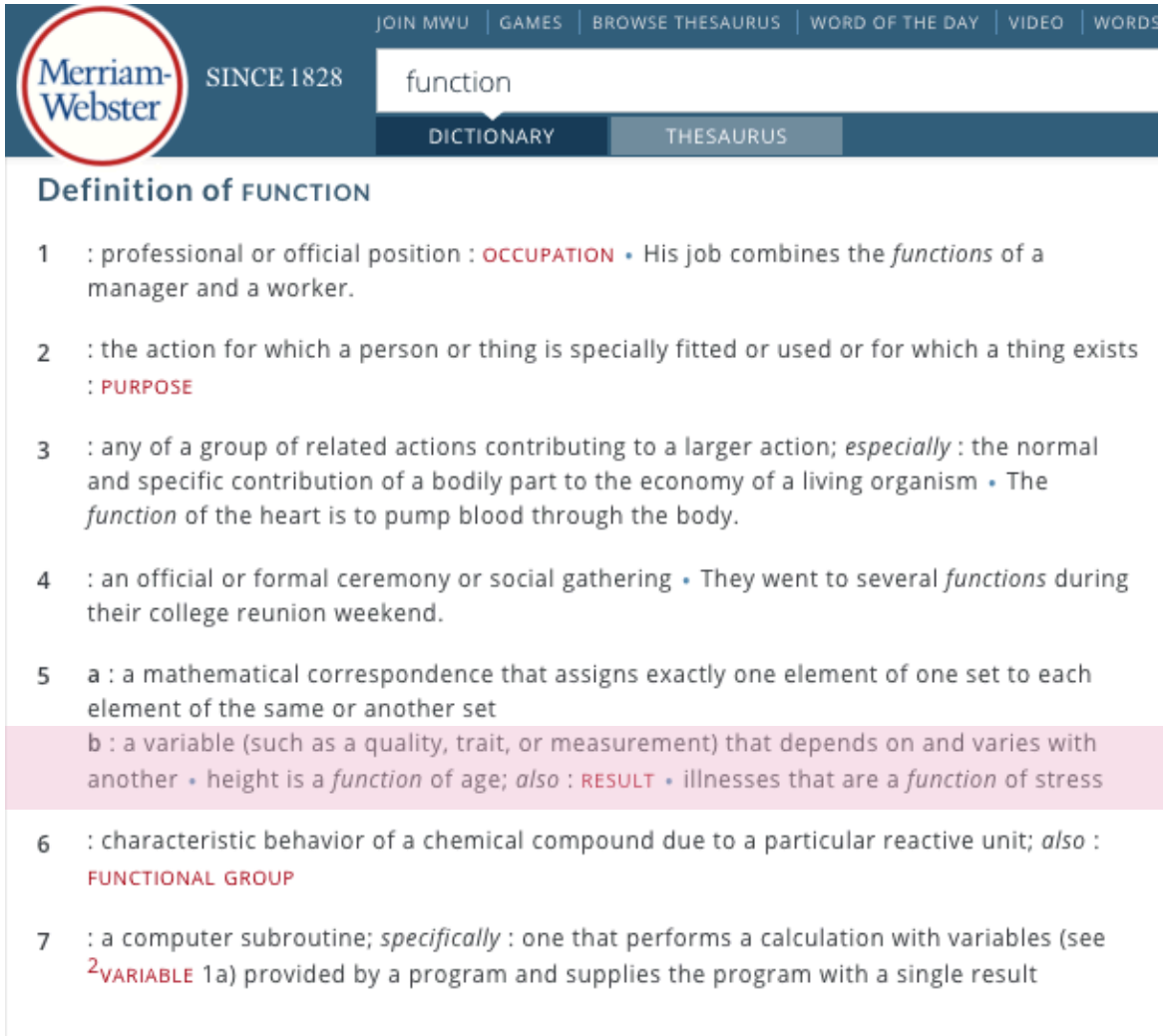
Worksheet (Handout): Due Today. Collaboration is encouraged.
Turn in one with the names of all contributors.
http://chemconnections.org/general/chem108/Math%20%26%20Measurements-WKS.f18.pdf

CHEM 108

Experiment 2:
Measuring Density

Comparison of Relative Properties

FUNCTIONS



Merriam-Webster SINCE 1828

JOIN MWU | GAMES | BROWSE THESAURUS | WORD OF THE DAY | VIDEO | WORDS

function

DICTIONARY | THESAURUS

Definition of FUNCTION

1 : professional or official position : OCCUPATION • His job combines the *functions* of a manager and a worker.

2 : the action for which a person or thing is specially fitted or used or for which a thing exists : PURPOSE

3 : any of a group of related actions contributing to a larger action; *especially* : the normal and specific contribution of a bodily part to the economy of a living organism • The *function* of the heart is to pump blood through the body.

4 : an official or formal ceremony or social gathering • They went to several *functions* during their college reunion weekend.

5 a : a mathematical correspondence that assigns exactly one element of one set to each element of the same or another set

b : a variable (such as a quality, trait, or measurement) that depends on and varies with another • height is a *function* of age; *also* : RESULT • illnesses that are a *function* of stress

6 : characteristic behavior of a chemical compound due to a particular reactive unit; *also* : FUNCTIONAL GROUP

7 : a computer subroutine; *specifically* : one that performs a calculation with variables (see ^{2}VARIABLE 1a) provided by a program and supplies the program with a single result

Density is a function of an object's mass and volume.

Comparisons of Relative Properties

FUNCTIONS

density : mass : volume

Functions & variables can be described interchangeably between:

1) Images (Symbols)
2) Words
3) Sounds (Voice)
4) Numbers
5) Tables
6) Graphs
7) Formulas

Density

Mass Volume

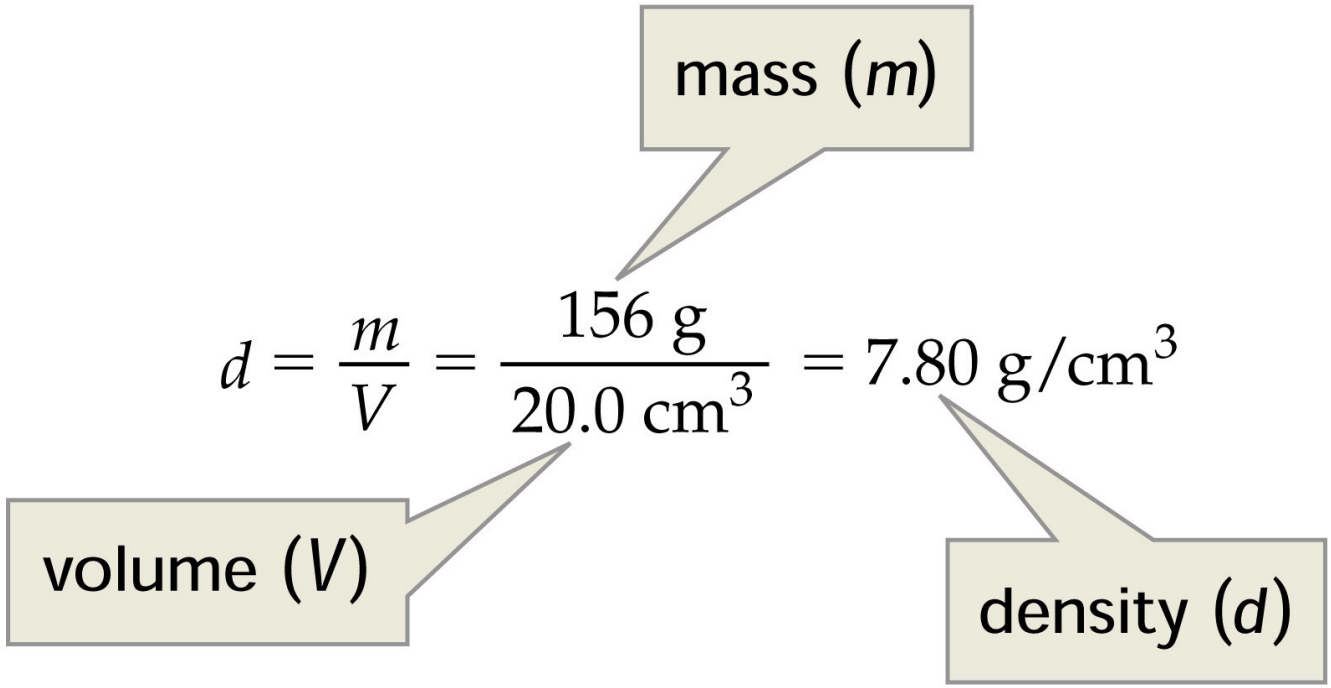
Density is a function of an object's mass and volume.

Density

Formulas

http://www.density.com/what.htm

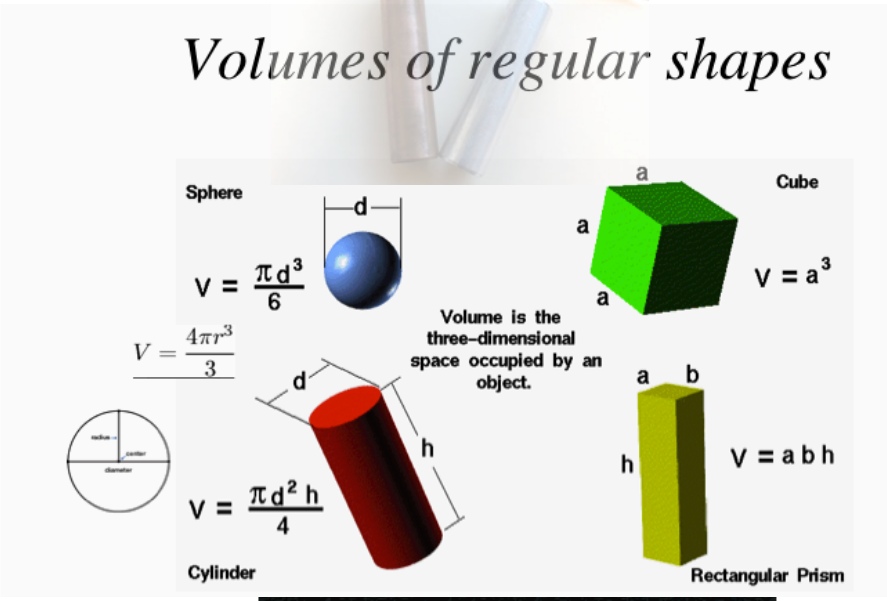
Density = Mass / Volume [g/mL or g/cm^3; g/L]

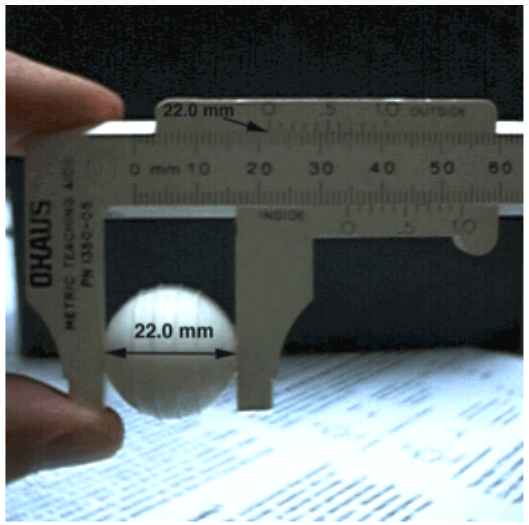


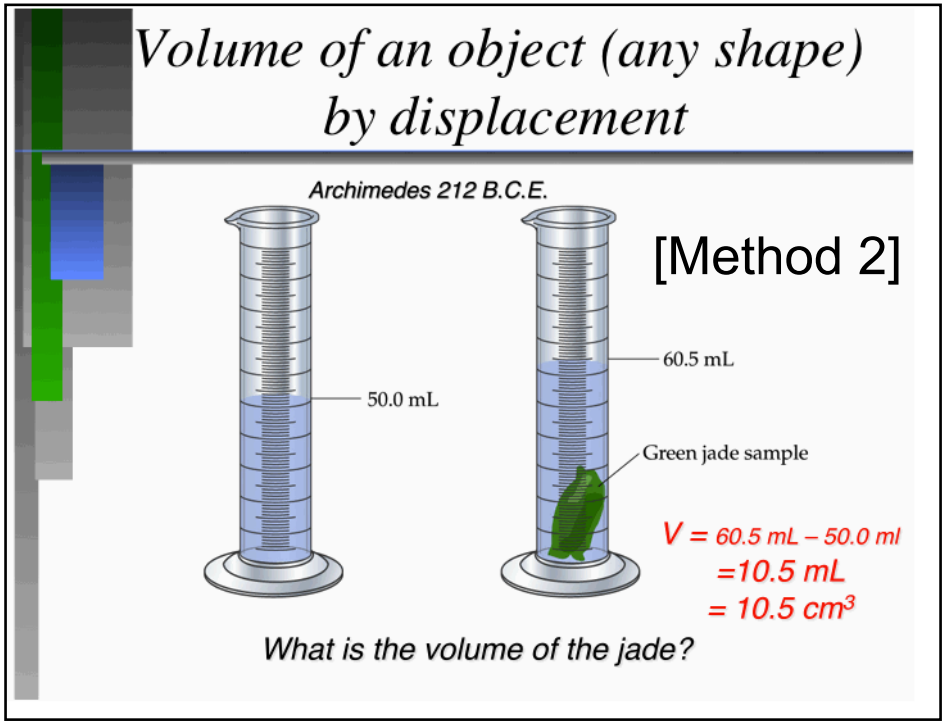
Experiment 2
Measuring Density

- ***Goal:*** To measure diameter and height of a metal cylinder and calculate the respective volume.
  - To plot mass versus volume and determine slope of "trendline(s)".
  - Using 2 different methods, to measure mass and volume of a liquid, and to determine which method results in *higher–precision* (*most decimal places*)
  - To measure mass and volume of a solid using instruments of different precision, and determine which method results in *highest–precision*
- ***Work with same lab partner(s) as the Metric Measurement Experiment***
  - Be sure to write yours and partners' names **ON both REPORT FORMS DUE Next Week**

Chem 108 Lab: Week 4

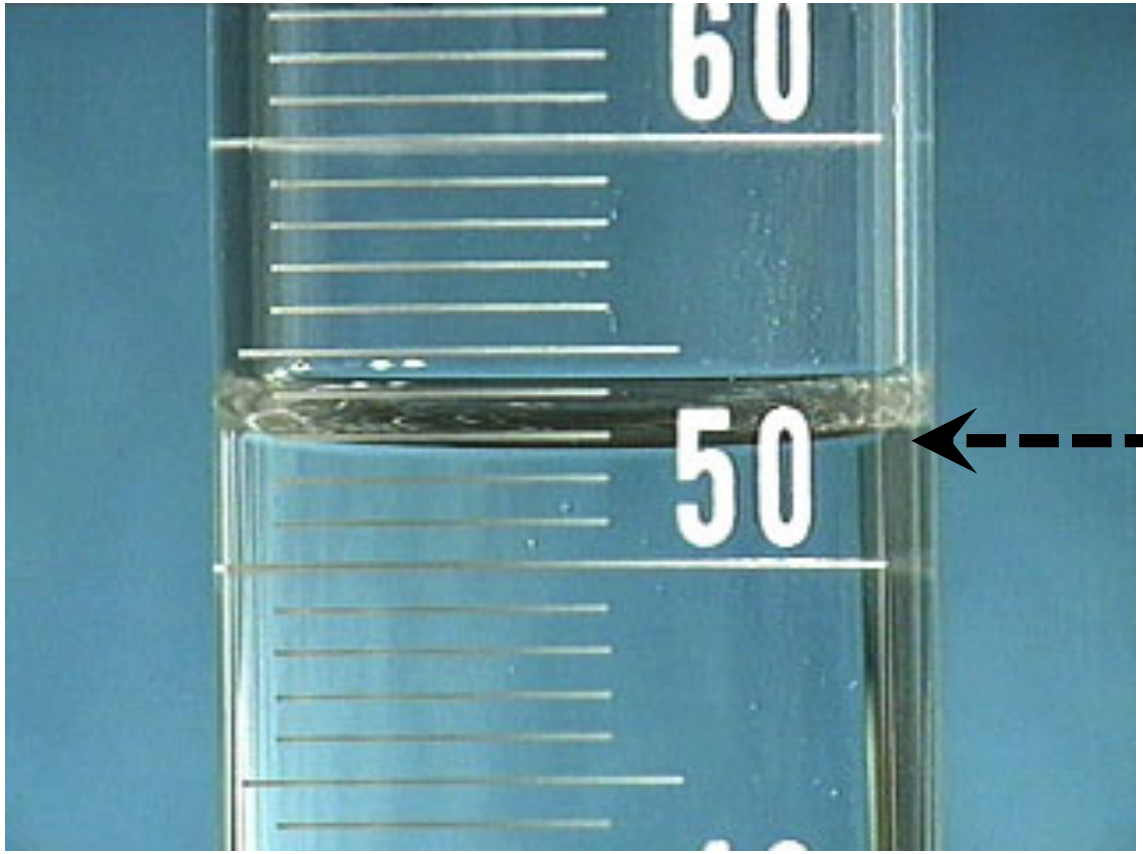


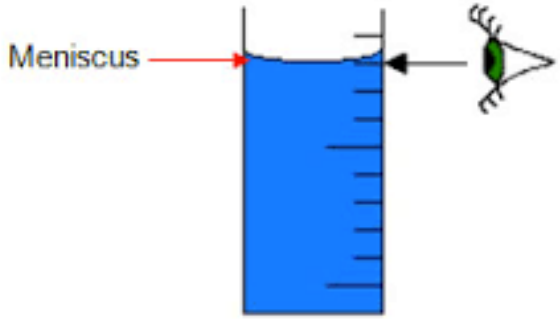




Reminder:

Measuring with a 100 mL Graduated Cylinder:



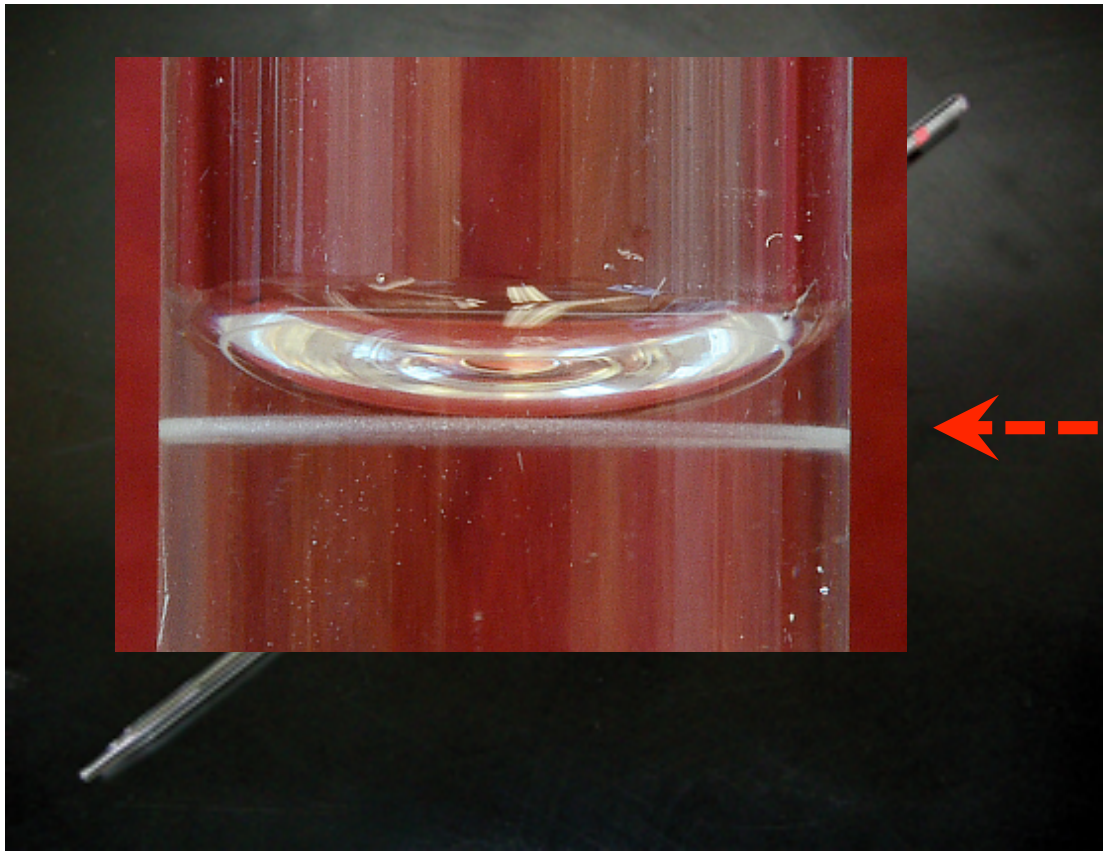


meniscus

Measure bottom of the meniscus at eye level

52.9 mL

- Measurement using a volumetric pipet:



meniscus

- ***Bottom of the meniscus MUST be at calibration line for accurate measurement***

➢ Add a column to pg. 22 & label both of them

Each partner to measure with both Caliper and Ruler & compare

Method 3–Measuring Volume with Calipers

	CALIPER	RULER
Mass, metal		
Height, metal		
Diameter, metal		
Radius, metal*		
Volume, metal*		
Density, metal*		

Densities of the Unknowns:

Part A– Average Density of Unknown Liquid from the two methods:

Density of Liquid (Graduated Cylinder)	
Density of Liquid (Volumetric Pipet)	
Average Density of Unknown Liquid*	

Part B– Average Density of Unknown Metal from all three methods:

Density of Metal (Graduated Cylinder)	
Density of Metal (Ungraduated Vial)	
Density of Metal (Ruler/Calipers)	
Average Density of Unknown Metal*	

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

➢ Replace Part C, pg. 19 with handout

http://chemconnections.org/general/chem108/Measuring%20Density-graphing.2017.pdf

Measuring Density (REPLACEMENT for Part-C page 19)

Part C-Mass Versus Volume

Select either Data Set for Metal A or Data Set for Metal B below to plot. You will do one and your partner will do the other Data Set.

Metal A

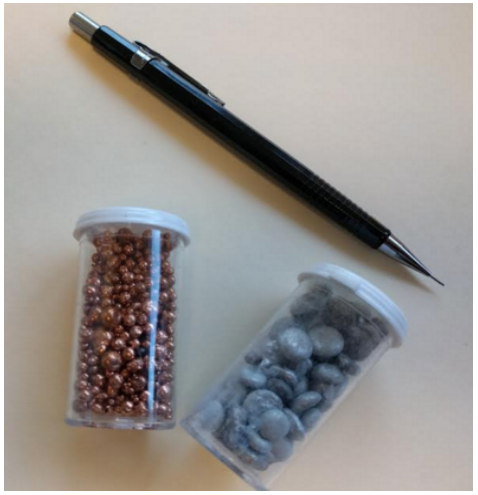
Volume (cm3)	Mass (g)
7.89	17.22
6.80	18.11
7.92	21.21
9.75	22.25
8.17	23.19
9.84	25.44
10.1	26.36
11.4	28.29
11.8	28.73
11.7	29.69

Metal B

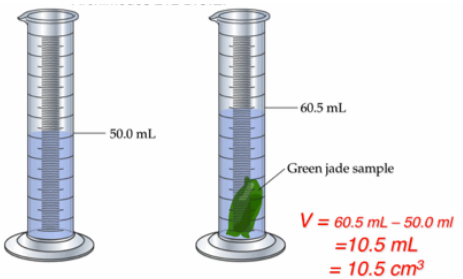
Volume (cm3)	Mass (g)
6.63	53.90
6.45	54.53
6.42	57.15
6.61	57.34
7.97	69.15
8.40	69.43
7.98	72.24
9.65	84.84
9.65	86.14
9.84	87.67

1. Calculate the respective densities for the metals using an average of the Mass and Volume for each metal. (Report the values in the table on this page and attach it along with your graphs to the REPORT FORM pages and turn in.)
2. Graph the Mass (vertical axis) vs. Volume (horizontal axis) for your Data Set (graph paper is in Appendix C). Scale your graph to use as much of the graph paper as possible. Provide a Title, label the axes (include units), show each data point and draw the best possible straight line balancing the differences in the distance of the points on each side of the line using a ruler. Draw the line through the y-axis. Calculate the slope of the line, slope (m) = $\Delta y / \Delta x$, which equals the metal's density. (Report the values below.)
3. The respective metals are either aluminum, density = 2.64 g/cm^3 or copper, density = 8.94 g/cm^3. Using these as accepted values, identify A and B, then calculate and record the calculated % error in the experimental densities using the two methods.

	A	B
Metal *identified*		
Density (g/cm^3) *averaged*		
Error (%) *averaged*		
Density (g/cm^3) *graphed*		
Error (%) *graphed*		



Method 2:

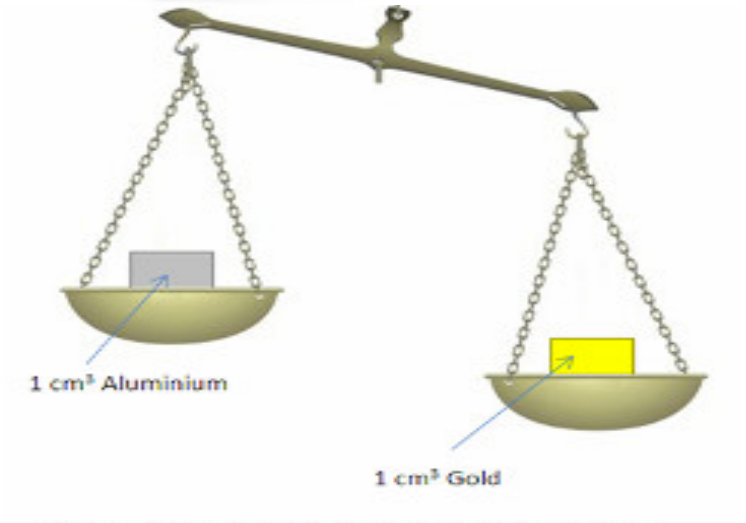


What is the volume of the jade?

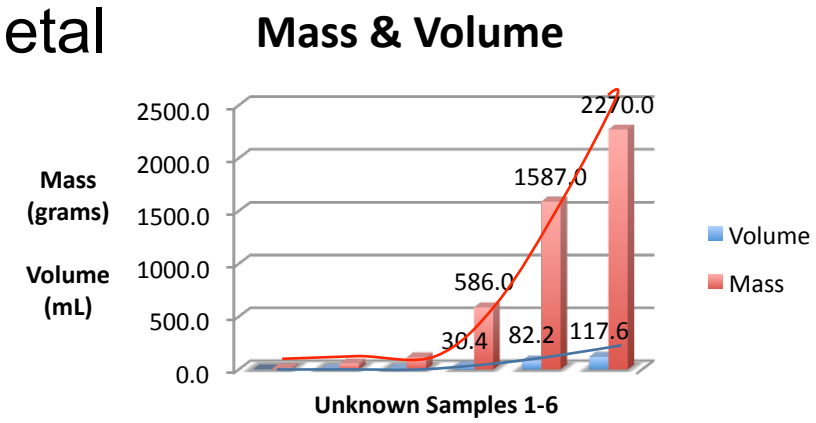
Density

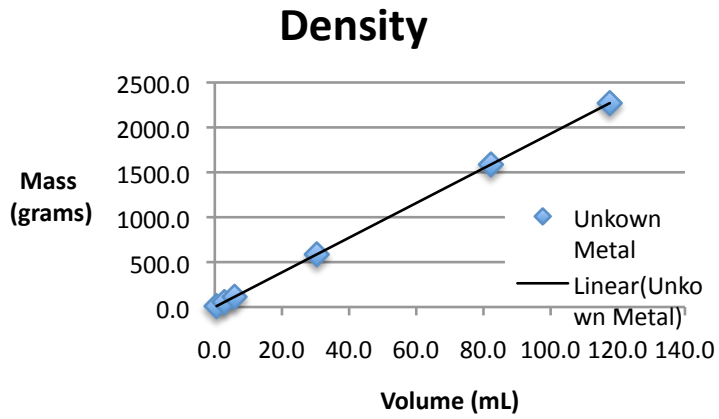
Mass & Volume

Numbers
Tables
Graphs



Metal





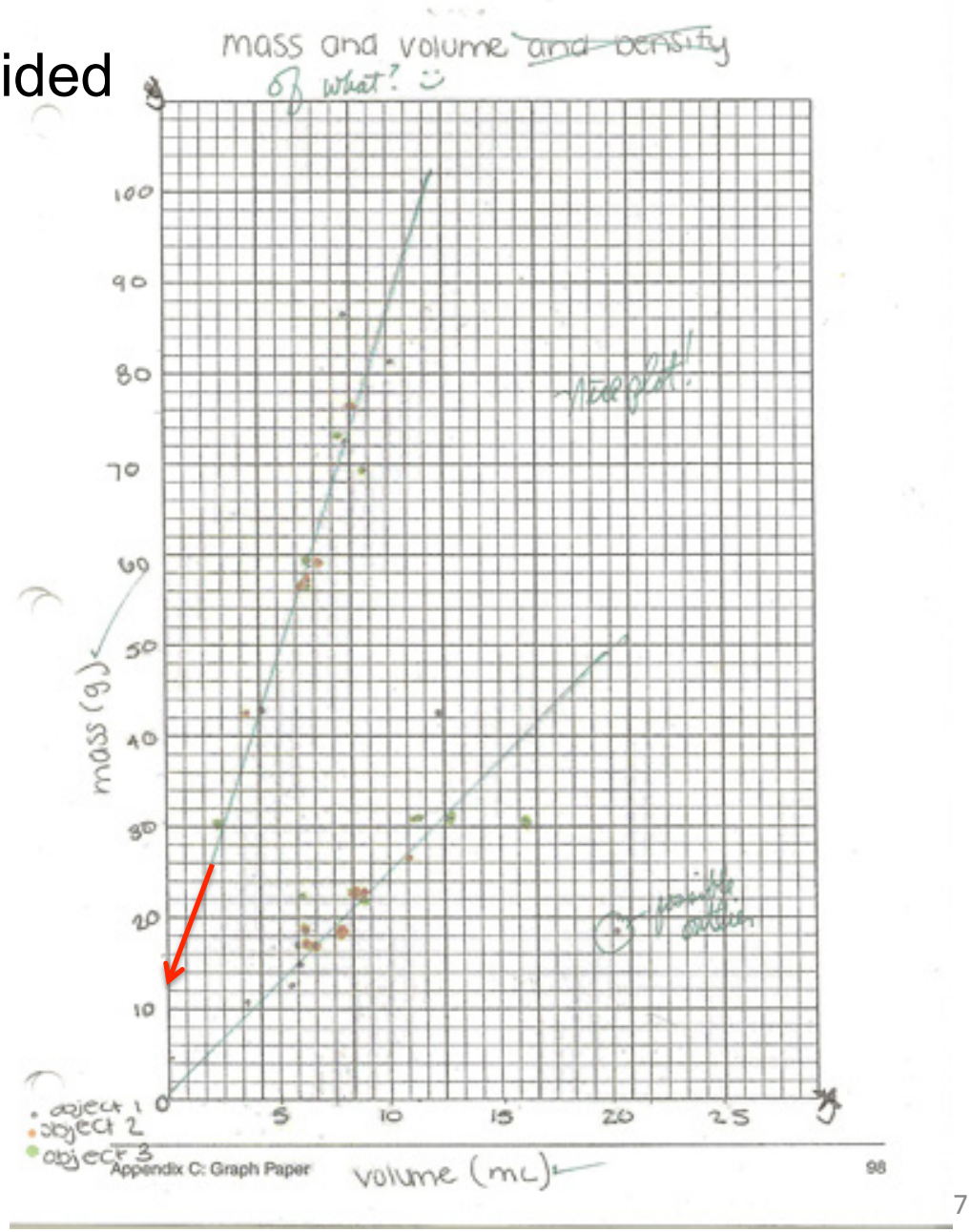
ables, & Graphs

- Plot data using blank graph paper in back of Lab Manual pp. 119 – 121

  Data & instructions are provided on handout

http:// chemconnections.org/general/chem108/Measuring Density-graphing.2017.pdf

- Plot all data for either Metal A (one partner) or Metal B (other partner): Can be on the same graph paper or separate. If on the same paper be sure to consult with partner on the scales to use.
- *Complete the bottom table of handout and attach to the Report Form to turn in.*



Equation of a line: $\Delta y = m\Delta x + b$

y = y axis m = slope x = x axis b = y-intercept

We're plotting: Mass = y axis Volume = x axis

- How are mass and volume related?

$$\frac{\Delta\, mass}{\Delta\, Volume} = density$$

We can rearrange this as: $mass = density(Volume)$

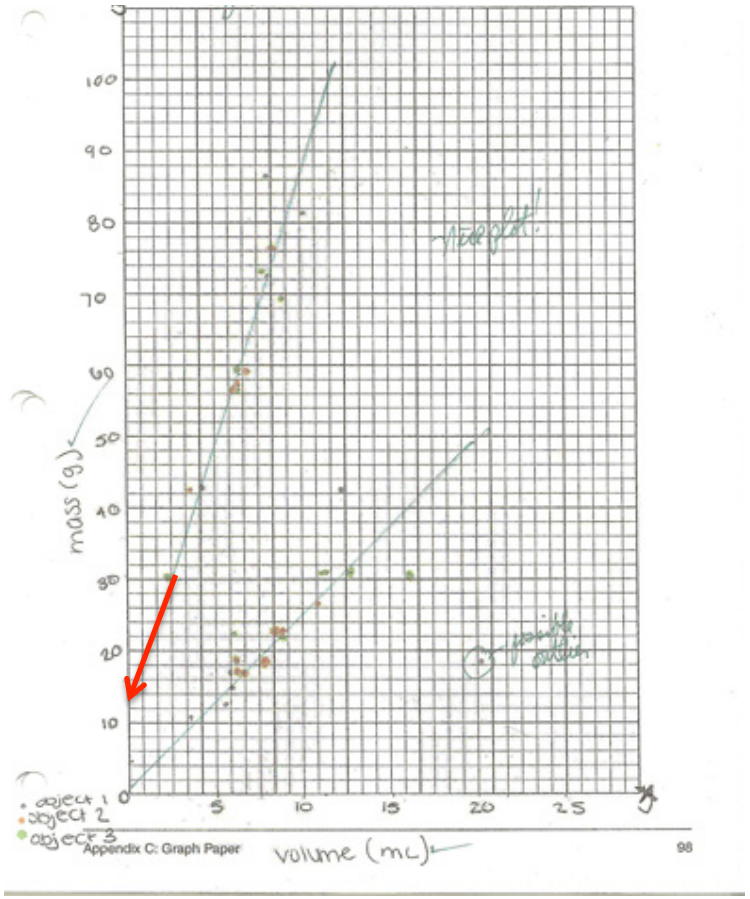
If we compare to equation of a line:

$$mass = density(Volume) + 0$$

$$\Delta y = m \Delta x + b$$

Now, what does the slope of our trendline represent?

- Plotting data
  - A good plot should have:
    - An appropriate scale
    - Labeled axes (with units)
    - An appropriate title



- *Use a ruler to estimate best-fit line for data that appears to group together (It is NOT connect-the-dots)*

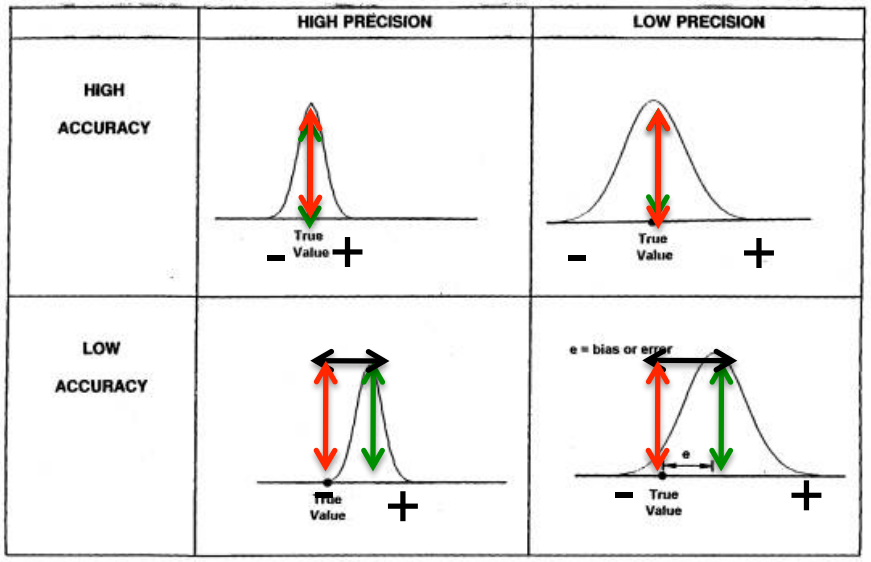
Experiment 2 – Measuring Density

- "Extrapolate your lines through the y (vertical) axis"
  - This means *draw your line all the way to the y-axis*

Error / Accuracy

$$Percent\ Error = \frac{Experimental\ value - True\ value}{True\ value} \times 100$$

4 experimental sets of data



Value = Average

True =1.0 g/mL
Exp. = 1.0 g/mL

True =1.0 g/mL
Exp. = 1.0 g/mL

True =1.0 g/mL
Exp. = 1.1 g/mL

True =1.0 g/mL
Exp. = 1.2 g/mL

QUESTION

Rank the relative accuracy of the three sets of data: a), b) and c). The accepted value is 8.08 mL.

Average		Average		Average
a)		b)		c)
8.38		8.38		7.99
Error = ?		Error = ?		Error = ?
Standard deviation a)		Standard deviation b)		Standard deviation c)
+/- 0.91		+/- 0.03		+/- 0.05

A) Accuracy: a > c > b

B) Accuracy: b > c > a

C) Accuracy: c > a = b

D) Accuracy: a = b > c

QUESTION

Rank the relative accuracy of the three sets of data: a), b) and c). The accepted value is 8.08 mL.

Average		Average		Average
a)		b)		c)
8.38		8.38		7.99
Error = ?		Error = ?		Error = ?
Standard deviation a)		Standard deviation b)		Standard deviation c)
+/- 0.91		+/- 0.03		+/- 0.05

A) Accuracy: a > c > b

B) Accuracy: b > c > a

Answer:
C) Accuracy: c > a = b

D) Accuracy: a = b > c

Experiment 2 – Measuring Density

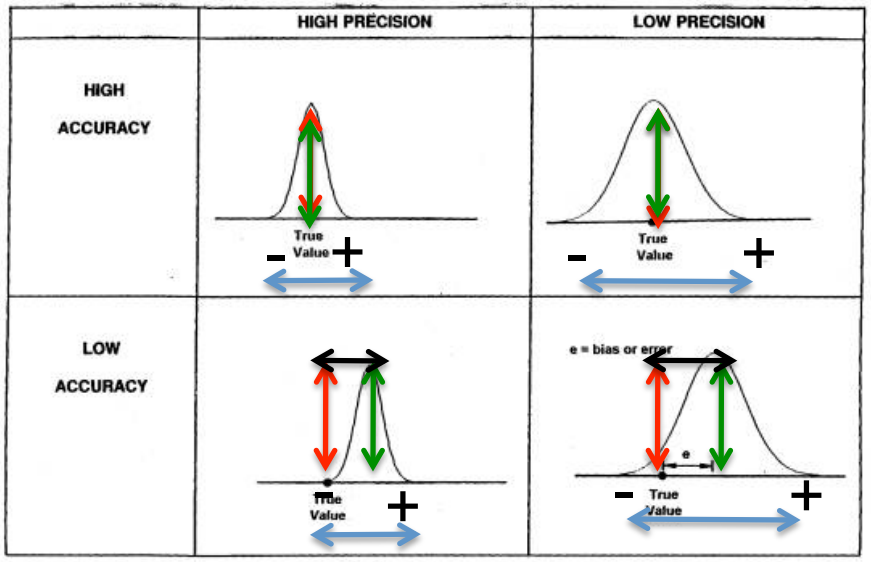
- "Extrapolate your lines through the y (vertical) axis"
  - This means *draw your line all the way to the y-axis*

Error / Accuracy & Precision

$$Percent\ Error = \frac{Experimental\ value - True\ value}{True\ value} \times 100$$

True =1.0 g/mL
Exp. = 1.0 +/- 0.1 g/mL

True =1.0 g/mL
Exp. = 1.1 +/- 0.1 g/mL



True =1.0 g/mL
Exp. = 1.0 +/- 0.2 g/mL

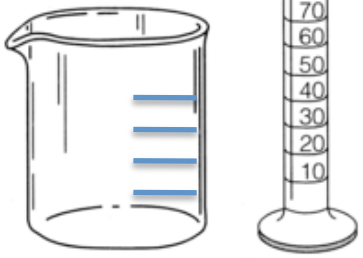
True =1.0 g/mL
Exp. = 1.2 +/- 0.2 g/mL

Different Volumetric Tools

Both =
+/- 0.01 mL

A

+/- 5 mL



+/- 0.1 mL

B C

+/- 0.01 mL

D

True (A) / False (B)

A and D have the same level of precision. True

The following is the correct order of increasing precision: D < C < B. False

QUESTION

Rank the relative precision of the three sets of data: a), b) and c). The accepted value is 8.08 mL.

Average		Average		Average
a)		b)		c)
8.38		8.38		7.99

Standard		Standard		Standard
deviation		deviation		deviation
a)		b)		c)
+/- 0.91		+/- 0.03		+/- 0.05

Answer:

A) Precision: a > c > b

B) Precision: b > c > a

C) Precision: a = b > c

D) Precision: a > b > c

➢ Complete both columns pg. 22

Each partner to measure with both Caliper and Ruler & compare

Method 3–Measuring Volume with Calipers

	CALIPER	RULER
Mass, metal		
Height, metal		
Diameter, metal		
Radius, metal*		
Volume, metal*		
Density, metal*		

Densities of the Unknowns:

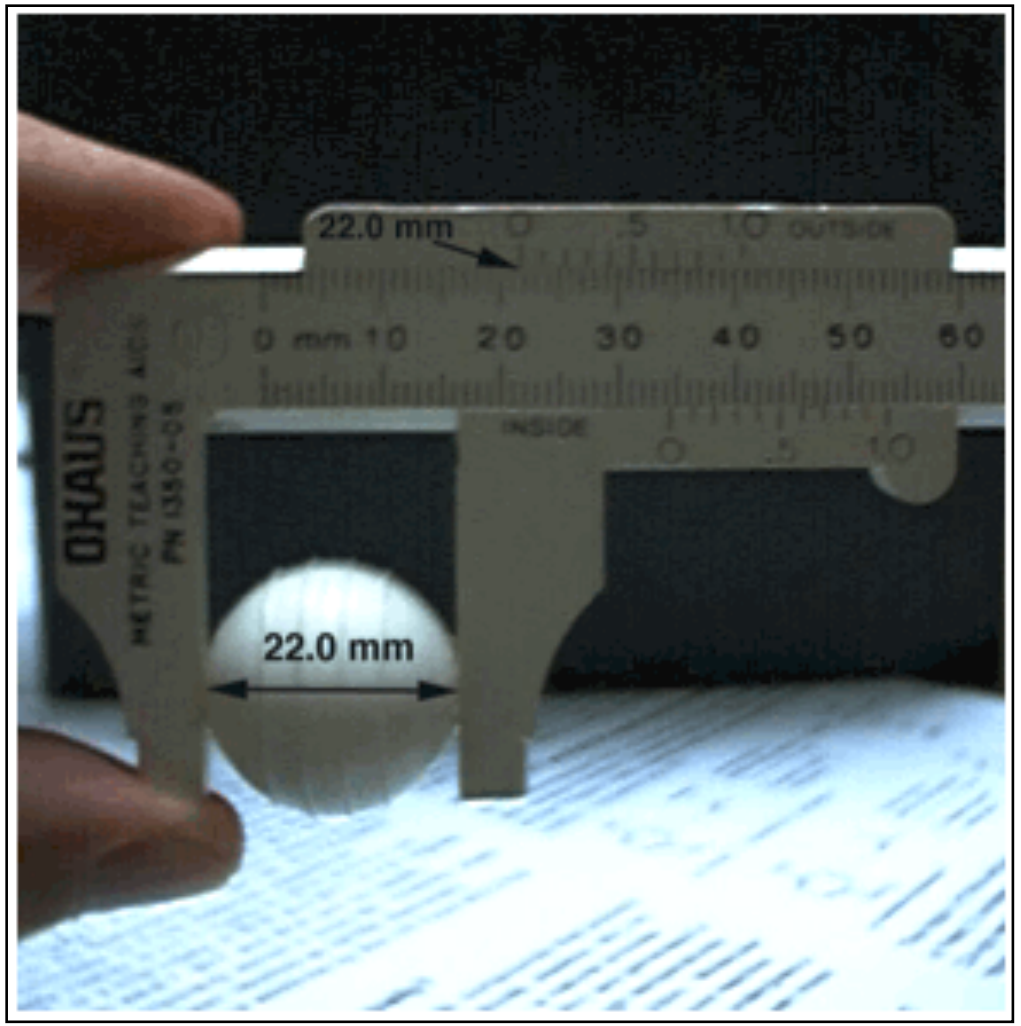
Part A– Average Density of Unknown Liquid from the two methods:

Density of Liquid (Graduated Cylinder)	
Density of Liquid (Volumetric Pipet)	
Average Density of Unknown Liquid*	

Part B– Average Density of Unknown Metal from all three methods:

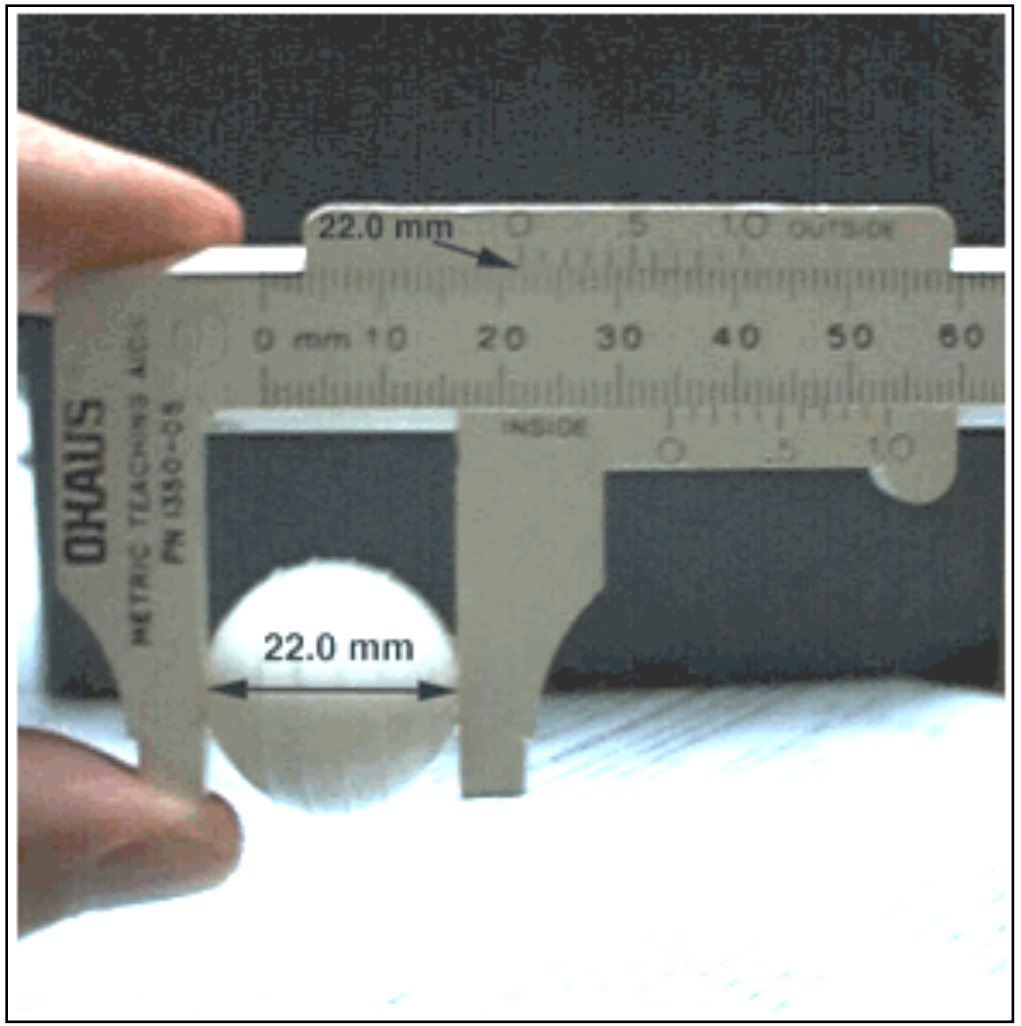
Density of Metal (Graduated Cylinder)	
Density of Metal (Ungraduated Vial)	
Density of Metal (Ruler/Calipers)	
Average Density of Unknown Metal*	

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.



Come up with partner having names on both lab forms.
Dr. R will provide unknown liquid & unknown metals, caliper & ruler.

Using a Caliper

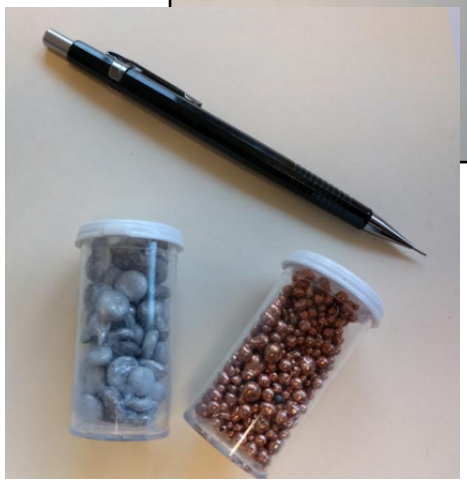


Measuring the cylinder

Read instructions carefully & discuss with partner before beginning.

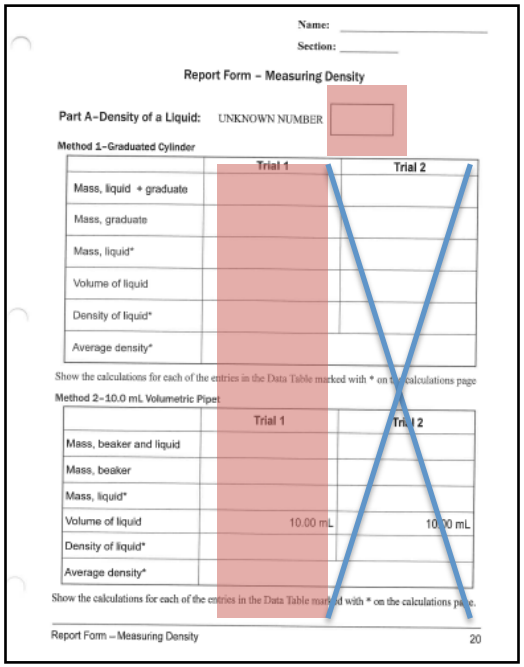
Return empty liquid vials & metal cylinders when finished.

Liquid is salt solution that can be poured down drain.



Experiment 2 –Measuring Density

Complete and record all measurements pp. 20-22 today. Omit pg. 23 and Trial 2 pg.20



Name: _____

Section: _____

Report Form – Measuring Density

Part A–Density of a Liquid: UNKNOWN NUMBER

Method 1–Graduated Cylinder

	Trial 1	Trial 2
Mass, liquid + graduate		
Mass, graduate		
Mass, liquid*		
Volume of liquid		
Density of liquid*		
Average density*		

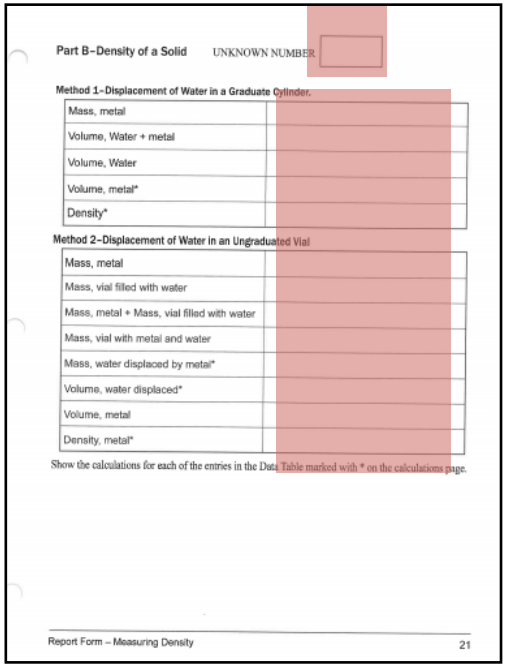
Show the calculations for each of the entries in the Data Table marked with * on the calculations page

Method 2–10.0 mL Volumetric Pipet

	Trial 1	Trial 2
Mass, beaker and liquid		
Mass, beaker		
Mass, liquid*		
Volume of liquid	10.00 mL	10.00 mL
Density of liquid*		
Average density*		

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Report Form – Measuring Density 20



Part B–Density of a Solid UNKNOWN NUMBER

Method 1–Displacement of Water in a Graduate Cylinder.

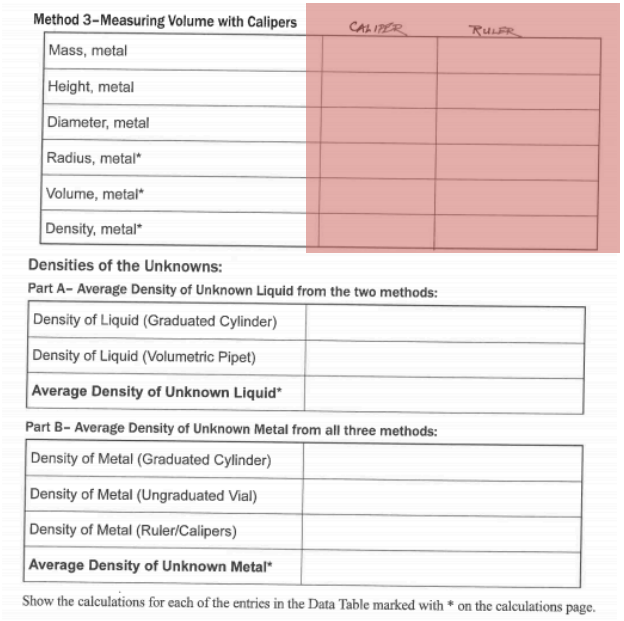
Mass, metal
Volume, Water + metal
Volume, Water
Volume, metal*
Density*

Method 2–Displacement of Water in an Ungraduated Vial

Mass, metal
Mass, vial filled with water
Mass, metal + Mass, vial filled with water
Mass, vial with metal and water
Mass, water displaced by metal*
Volume, water displaced*
Volume, metal
Density, metal*

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Report Form – Measuring Density 21



Method 3–Measuring Volume with Calipers

	CALIPER	RULER
Mass, metal		
Height, metal		
Diameter, metal		
Radius, metal*		
Volume, metal*		
Density, metal*		

Densities of the Unknowns:

Part A– Average Density of Unknown Liquid from the two methods:

Density of Liquid (Graduated Cylinder)	
Density of Liquid (Volumetric Pipet)	
Average Density of Unknown Liquid*	

Part B– Average Density of Unknown Metal from all three methods:

Density of Metal (Graduated Cylinder)	
Density of Metal (Ungraduated Vial)	
Density of Metal (Ruler/Calipers)	
Average Density of Unknown Metal*	

Show the calculations for each of the entries in the Data Table marked with * on the calculations page.

Have Dr. R. sign **individual** forms before leaving lab today.
Only your measurement data is due to be signed today.
Be certain of calculations, graphs & questions before leaving lab.

For Next Week

- Check Calendar for assignments
- Complete density calculations, graphs & Report Form pp.20-22, & pp. 24-25; attach completed replacement pg. 19 plus graphs (One complete set for each lab partner to be turned in; stapled together clearest report first.)

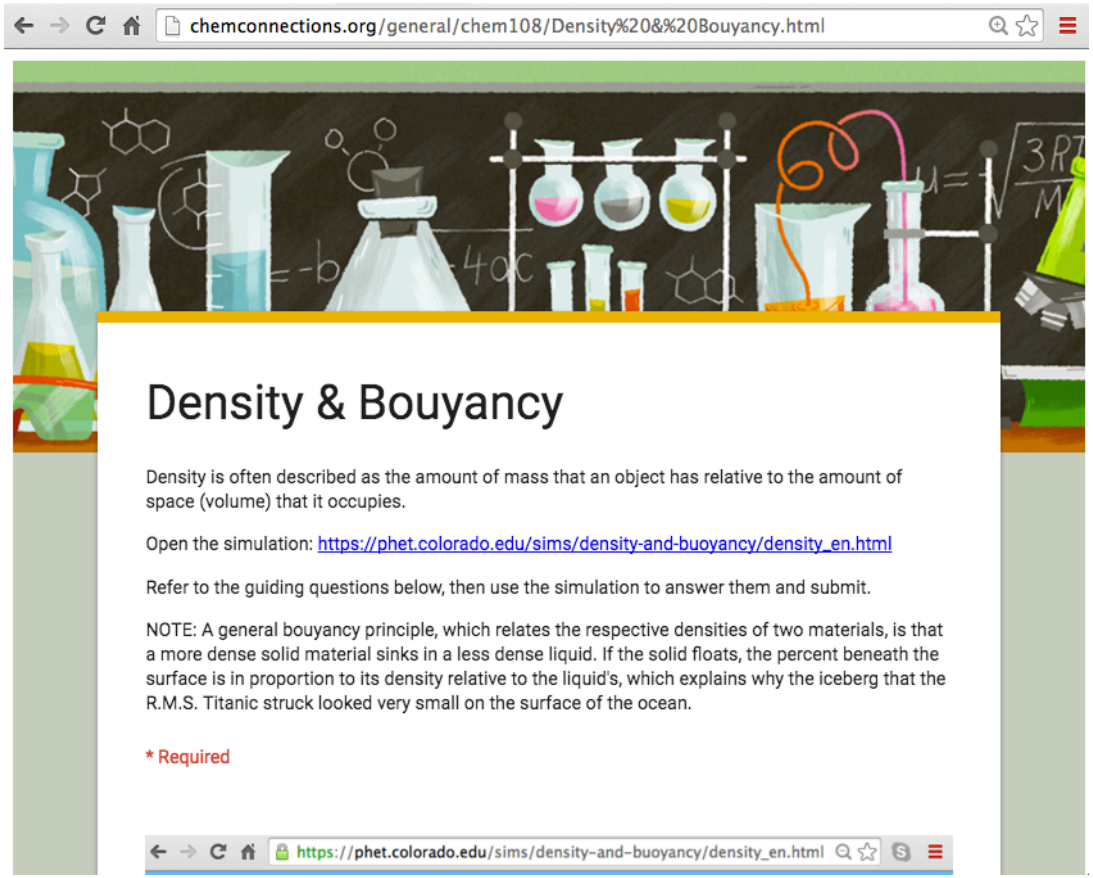
  DUE Next Lab Period
- (GQ) On-line *Density & Buoyancy Guiding Questions* (individually done)

  https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html
- DUE Next Lab Period

- (GQ) On-line *Density & Buoyancy Guiding*

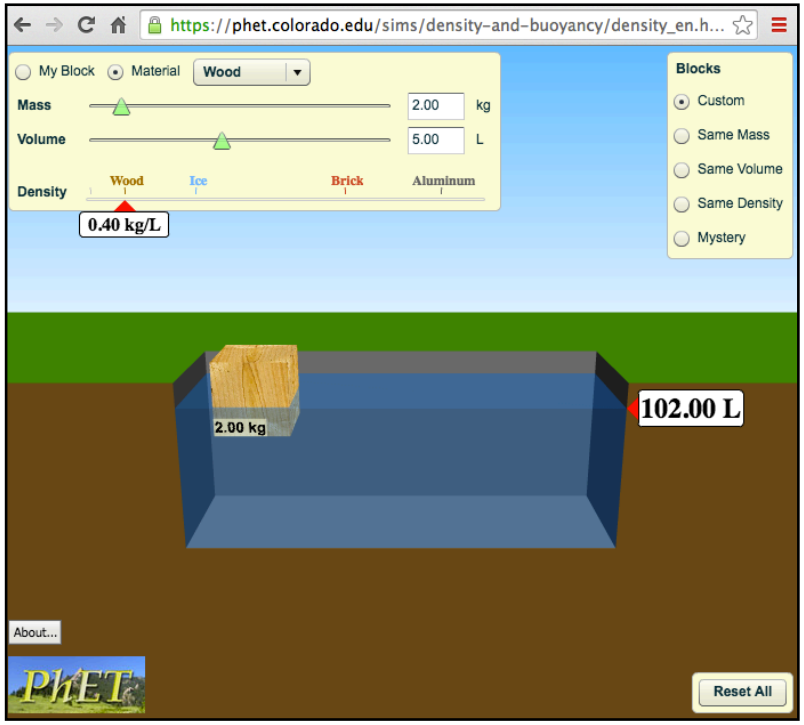
DUE Next Lab Period

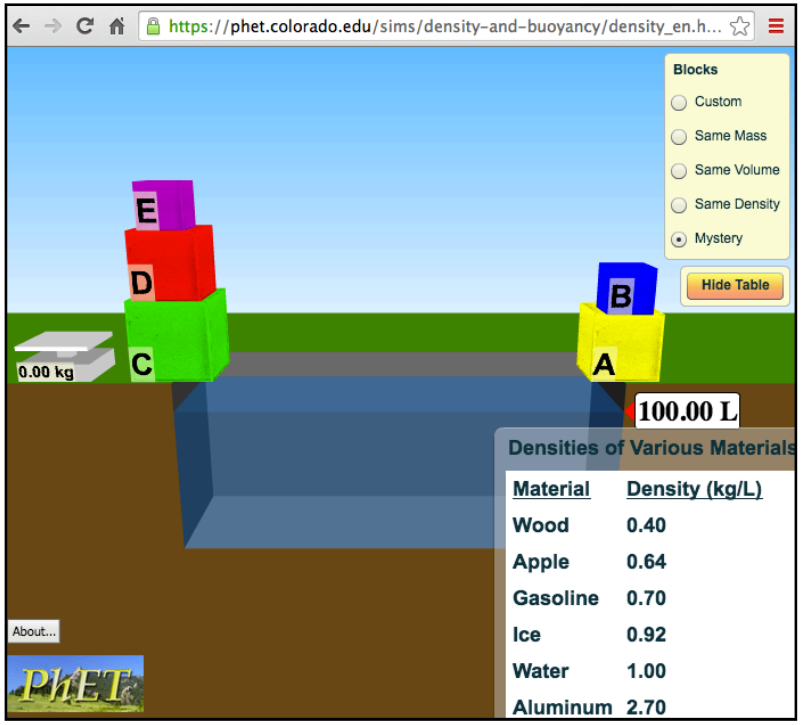
http://chemconnections.org/general/chem108/Density%20&%20Bouyancy.html



- (GQ) On-line *Density & Buoyancy* *Guiding Questions* DUE Next Lab Period

https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html





Come to Dr. R. with partners having names on both lab forms.

Dr. R will provide unknown liquid, caliper & ruler. Metal cylinders are to be shared.

Read instructions carefully & discuss with partner before beginning.

Return empty liquid vials & metal cylinders when finished. Liquid is salt solution that can be poured down drain.