


**Chem 108: Lab**

Sign in: Roster @ front of lab  
 Pick up replacement page for today's experiment.  
 Work with partner from last week's lab.

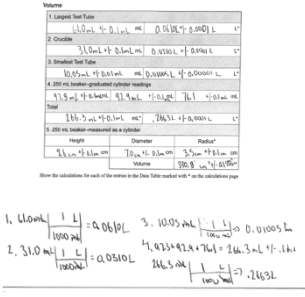
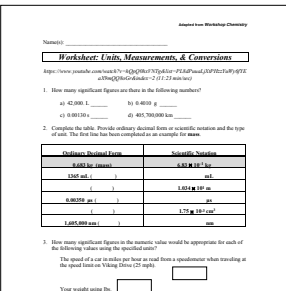
**Last Week's Experiment #1  
 Metric Measurement**  
 Completed individual forms pp. 12-15  
 due today by the end of lab.



Include calculations. Staple together with partner's form  
 and turn in before the end of lab.  
 Most legible report pages on top.

**Metric Measurement: Experiment #1**

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

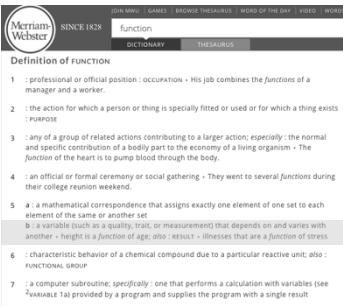



**Worksheet (Handout): Due Today**  
 Turn in individually  
<http://chemconnections.org/general/chem108/Math%20%26%20Measurements-WKS.f18.pdf>

**CHEM 108**

**Experiment #2:  
 Measuring Density**

**Comparison of Relative Properties  
 FUNCTIONS**



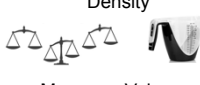
Density is a function of an object's mass and volume.

### 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

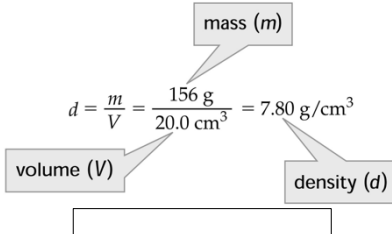
Mass      Volume

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<sup>3</sup>; g/L]



### Experiment #2 Measuring Density

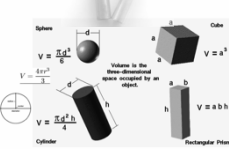
➤ **Do Today**


➤ **Goal:**

- 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*
- 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)".
- **Work with same lab partner as the Metric Measurement Experiment**
  - Be sure to write yours and partners' names **ON both REPORT FORMS DUE Week #5**

### ➤ Do Today Chem 108 Lab: Experiment #2

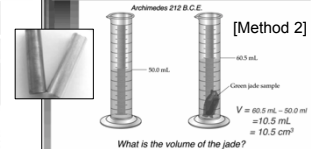
Volumes of regular shapes





#### Volume of an object (any shape) by displacement

*Archimedes 212 B.C.E.*



**[Method 2]**

30.0 mL      40.5 mL

Water      Carbon jades sample

$V = 40.5 \text{ mL} - 30.0 \text{ mL} = 10.5 \text{ mL} = 10.5 \text{ cm}^3$

What is the volume of the jade?


### Measuring Density

Read instructions carefully & discuss with partner before beginning. (pp. 16-19 + handout)

Part A: Unknown Liquid  
Method 1  
Method 2

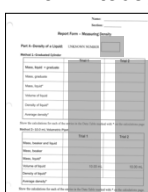

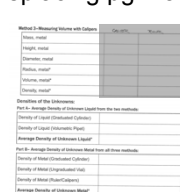
Part B: Density of Solid  
Method 1  
Method 2  
Method 3  
(Top of pg.19)

Part C (handout)  
Data Provided  
(no measurements)



### Experiment #2 –Measuring Density

Complete and record all measurements pp. 20-22 today. Plus handout replacing pg. 23

Have **individual** forms initialed before leaving lab today. Only your measurement data & graph are due to be signed today. Be certain of calculations, graphs & questions before leaving lab.

➤ Replace Part C, pg. 19 with handout, which also replaces pg. 23 in Report form as well.

**Measuring Density (REPLACEMENT for Part C, page 19)**

Part C: Mass Versus Volume

Divide either Data Set for Metal A or Data Set for Metal B below in just. You will do one and your partner will do the other Data Set.

Metal A		Metal B	
Volume (mL)	Mass (g)	Volume (mL)	Mass (g)
1.00	1.78	1.00	38.00
2.00	3.57	2.00	76.00
3.00	5.35	3.00	114.00
4.00	7.14	4.00	152.00
5.00	8.93	5.00	190.00
6.00	10.71	6.00	228.00
7.00	12.50	7.00	266.00
8.00	14.29	8.00	304.00
9.00	16.07	9.00	342.00
10.00	17.86	10.00	380.00
11.00	19.64	11.00	418.00
12.00	21.43	12.00	456.00
13.00	23.21	13.00	494.00
14.00	25.00	14.00	532.00

- 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 FOLDER pages and turn in.)
- 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 both data points 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 points. Calculate the slope of the line, slope (m) =  $\Delta y / \Delta x$ , which equals the metal's density. (Report the results below.)
- The respective metals are either aluminum, density = 2.70 g/cm<sup>3</sup> or copper, density = 8.96 g/cm<sup>3</sup>. Using these as accepted values, identify A and B, then calculate and record the calculated % error in the experimental densities using the two methods. (Report the results below.)

	A	B
Metal identified		
Density (g/cm <sup>3</sup> ) averaged		
Error (%) averaged		
Density (g/cm <sup>3</sup> ) graphed		
Error (%) graphed		

Method 2: What is the volume of the object?

$V = 60.0 \text{ mL} - 50.0 \text{ mL} = 10.0 \text{ mL}$

$D = \frac{m}{V} = \frac{89.2 \text{ g}}{10.0 \text{ mL}} = 8.92 \text{ g/cm}^3$

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

### Experiment #2 – Measuring Density

Complete and record all measurements

**Part A: Unknown Liquid**  
**Method 1: (2 Trials)**  
 Graduated Cylinder

**Method 2: (2 Trials)**  
 Pipet

### Different Volumetric Tools

Both = +/- 0.01 mL

A +/- 5 mL      B +/- 0.1 mL      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**

**Reminder:**  
 Measuring with a 100 mL Graduated Cylinder:

Meniscus

meniscus

**Measure bottom of the meniscus at eye level**

52.9 mL

➤ Measurement using a volumetric pipet:

Volumetric pipet

<https://www.youtube.com/watch?v=HC44xjs7dho>

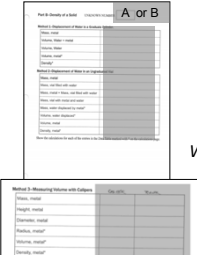
➤ Measurement using a volumetric pipet:

meniscus

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

### Experiment #2 –Measuring Density

Complete and record all measurements




**Method 1**  
Water Displacement (Grad. Cylinder)

**Method 2**  
Water Displacement (Using Unk. Liq. Vial)


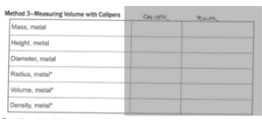
**Method 3**  
Caliper + Ruler  
(Top of pg.19)

**Part B: Density of Solid (Metal Cylinder)**




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

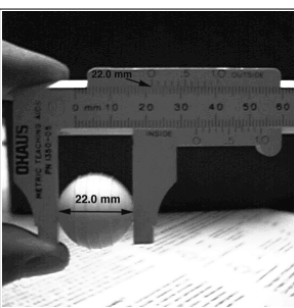
Each partner to measure individual metal cylinder with both a Caliper and Ruler



➤ Complete both columns pg. 22

Each partner to measure with both Caliper and Ruler & compare



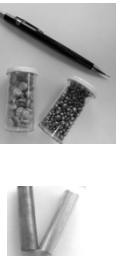


➤ Replacement Part C, pg. 19 (handout)  
Replaces pg. 23 in Report form.

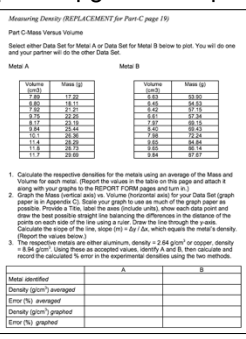



<http://chemconnections.org/general/chem108/Measuring%20Density-graphing.2017.pdf>

➤ Replacement Part C, pg. 19 (handout)  
Replaces pg. 23 in Report form.




**Method 2:**



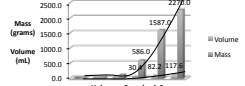
<http://chemconnections.org/general/chem108/Measuring%20Density-graphing.2017.pdf>

## Density Mass & Volume

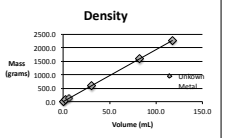


**Numbers Tables Graphs**

**Metal Mass & Volume**



**Density**



**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?

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

We can rearrange this as:    $\text{mass} = \text{density}(\text{Volume})$

If we compare to equation of a line:

$$\text{mass} = \text{density}(\text{Volume}) + 0$$

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

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**

Complete and record all measurements pp. 20-22 today. Plus handout replacing pg. 23

Have **individual** forms initialed before leaving lab today. Only measurement data and graph due to be signed today. Be certain of calculations, handout table & questions before leaving lab.

- (GQ) On-line Density & Buoyancy Guiding DUE Week #5

<http://chemconnections.org/general/chem108/Density%20&%20Buoyancy.html>

- (GQ) On-line Density & Buoyancy Guiding Questions DUE Week #5

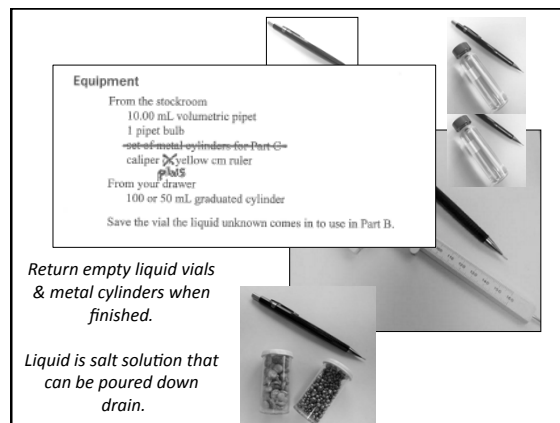
[https://phet.colorado.edu/sims/density-and-buoyancy/density\\_en.html](https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html)

### Next Week: (Week #5)

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

DUE Week #5

- (GQ) On-line *Density & Buoyancy Guiding Questions* (individually done)  
[https://phet.colorado.edu/sims/density-and-buoyancy/density\\_en.html](https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html)
- DUE Week #5



**Equipment**

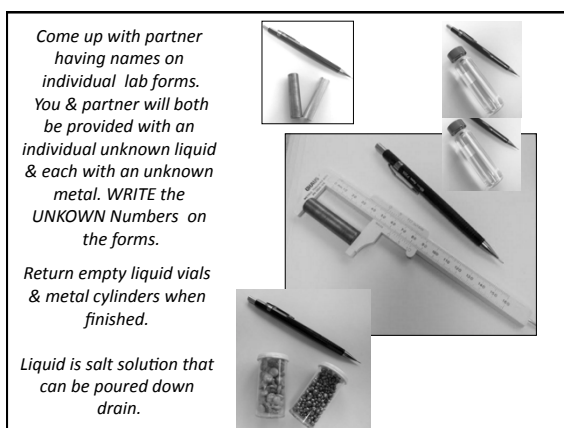
From the stockroom  
10.00 mL volumetric pipet  
1 pipet bulb  
~~set of metal cylinders for Part C~~  
caliper ~~yellow cm ruler~~  
ruler

From your drawer  
100 or 50 mL graduated cylinder

Save the vial the liquid unknown comes in to use in Part B.

*Return empty liquid vials & metal cylinders when finished.*

*Liquid is salt solution that can be poured down drain.*



*Come up with partner having names on individual lab forms. You & partner will both be provided with an individual unknown liquid & each with an unknown metal. WRITE the UNKOWN Numbers on the forms.*

*Return empty liquid vials & metal cylinders when finished.*

*Liquid is salt solution that can be poured down drain.*