

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.

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.

Metric Measurement: Experiment #1

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 \pm 0.1 mL mL | 0.0610 L \pm 0.0001 L | L* |
| 2. Crucible | | |
| 31.0 mL \pm 0.1 mL mL | 0.0310 L \pm 0.0001 L | L* |
| 3. Smallest Test Tube | | |
| 10.05 mL \pm 0.01 mL mL | 0.01005 L \pm 0.00001 L | L* |
| 4. 250 mL beaker—graduated cylinder readings | | |
| 97.8 mL \pm 0.1 mL mL | 92.9 mL \pm 0.1 mL mL | 76.1 \pm 0.1 mL mL |
| Total | | |
| 266.3 mL \pm 0.1 mL mL* | .2663 L \pm 0.0001 L | L* |
| 5. 250 mL beaker—measured as a cylinder | | |
| Height | Diameter | Radius* |
| 4.6 cm \pm 0.1 cm cm | 7.0 cm \pm 0.1 cm cm | 3.5 cm \pm 0.1 cm cm |
| | Volume | 330.8 cm ³ \pm 0.1 cm ³ * |

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

$$1. \frac{61.0 \text{ mL}}{1000 \text{ mL}} = 0.0610 \text{ L}$$

$$2. \frac{31.0 \text{ mL}}{1000 \text{ mL}} = 0.0310 \text{ L}$$

$$3. \frac{10.05 \text{ mL}}{1000 \text{ mL}} \Rightarrow 0.01005 \text{ L}$$

$$4. 97.3 + 92.9 + 76.1 = 266.3 \text{ mL} \pm 0.1 \text{ mL}$$

$$\frac{266.3 \text{ mL}}{1000 \text{ mL}} \Rightarrow 0.2663 \text{ L}$$

Name(s): _____

Worksheet: Units, Measurements, & Conversions

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

- How many significant figures are there in the following numbers?
 - 42,000. L _____
 - 0.4010 g _____
 - 0.00130 s _____
 - 405,700,000 km _____
- 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 μ s () | μ s |
| () | 1.75×10^{-3} cm ³ |
| 1,605,000 nm () | nm |

- 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.

Worksheet (Handout): Due Today
Turn in individually

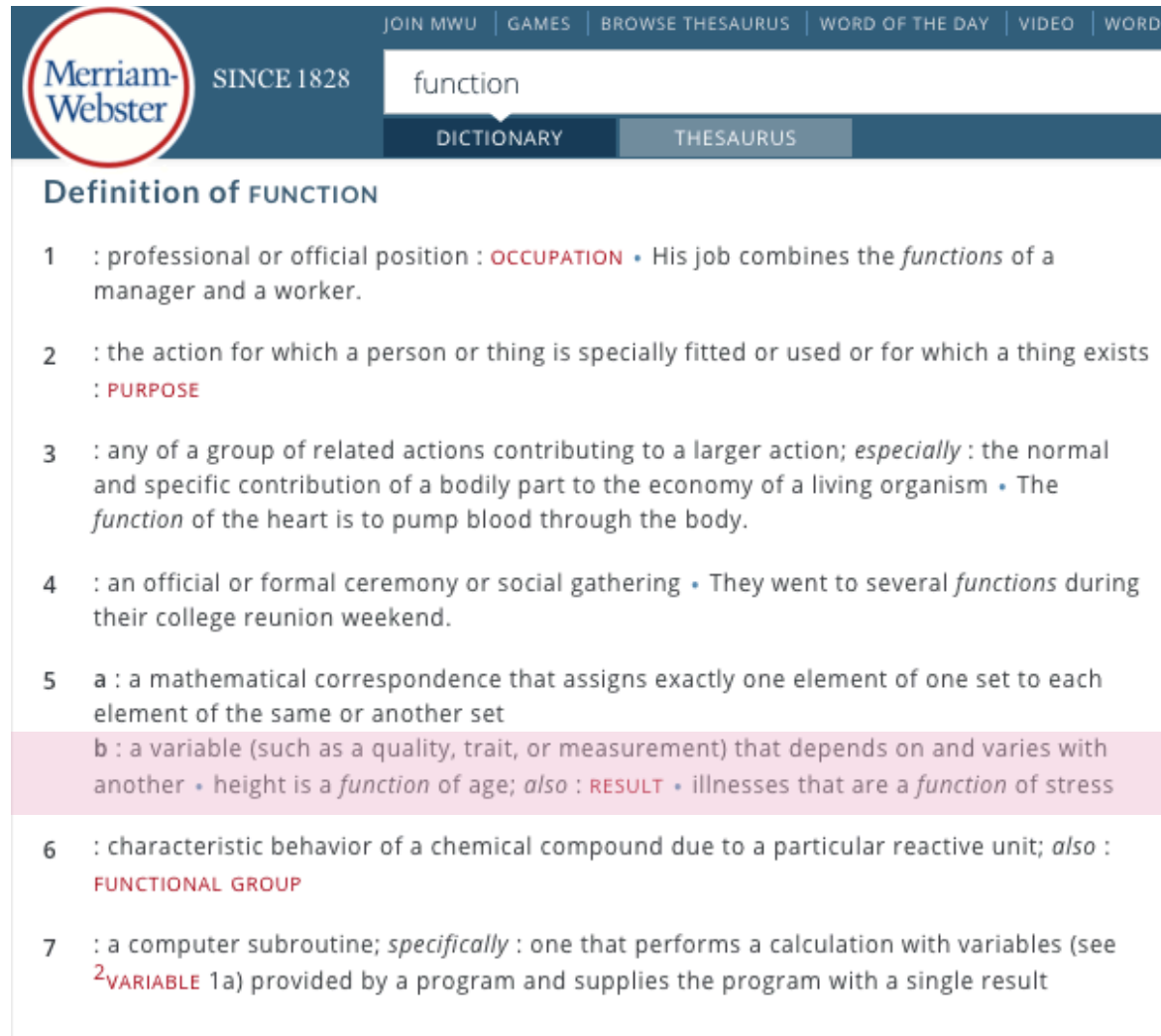
<http://chemconnections.org/general/chem108/Math%20%26%20Measurements-WKS.f18.pdf>

CHEM 108

Experiment #2: Measuring Density

Comparison of Relative Properties

FUNCTIONS



The image shows a screenshot of the Merriam-Webster website. At the top, there is a navigation bar with links for 'JOIN MWU', 'GAMES', 'BROWSE THESAURUS', 'WORD OF THE DAY', 'VIDEO', and 'WORDS'. The Merriam-Webster logo is on the left, with 'SINCE 1828' next to it. A search bar contains the word 'function'. Below the search bar are two tabs: 'DICTIONARY' (selected) and 'THESAURUS'. The main content area is titled 'Definition of FUNCTION' and lists seven numbered definitions. The fifth definition is highlighted in a light pink background.

Merriam-Webster SINCE 1828

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 **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

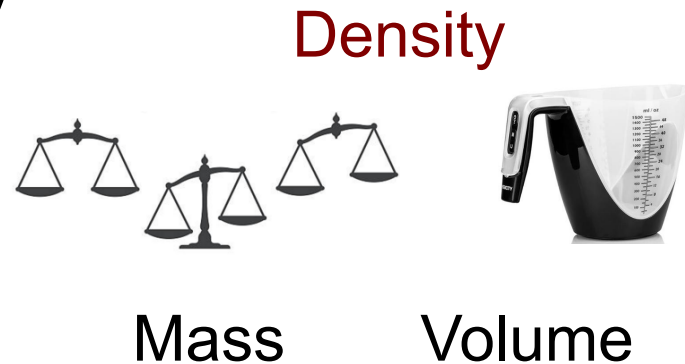
3) Sounds (Voice)

4) Numbers

5) Tables

6) Graphs

7) Formulas



Density 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/cm³; g/L]

The diagram illustrates the density formula $d = \frac{m}{V}$ with a numerical example. A callout box labeled "mass (m)" points to the numerator "156 g". A callout box labeled "volume (V)" points to the denominator "20.0 cm³". A callout box labeled "density (d)" points to the result "7.80 g/cm³".

$$d = \frac{m}{V} = \frac{156 \text{ g}}{20.0 \text{ cm}^3} = 7.80 \text{ g/cm}^3$$

Experiment #2

➤ Do Today

Measuring Density

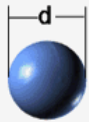
- **Goal:**
- Using 2 different methods, to measure mass and volume of a liquid, and to determine which method results in *higher-precision (most decimal places)*
- To measure mass and volume of a solid using instruments of different precision, and determine which method results in *highest-precision*
- 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

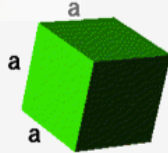
Sphere



$$V = \frac{\pi d^3}{6}$$

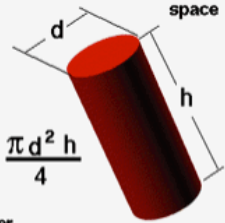
$$V = \frac{4\pi r^3}{3}$$

Volume is the three-dimensional space occupied by an object.



Cube

$$V = a^3$$



$$V = \frac{\pi d^2 h}{4}$$

Cylinder



$$V = a b h$$

Rectangular Prism

YouTube

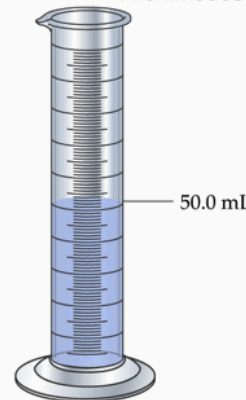
Search



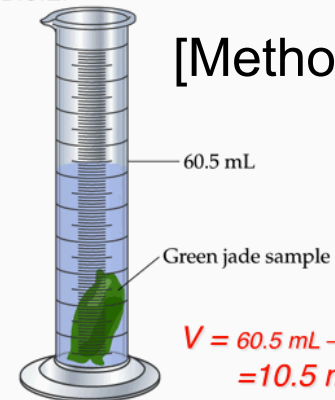
Volume of an object (any shape) by displacement

Archimedes 212 B.C.E.

[Method 2]



50.0 mL

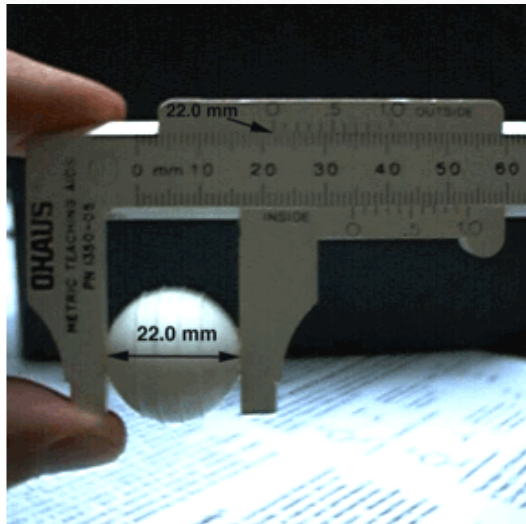


60.5 mL

Green jade sample

$$\begin{aligned} V &= 60.5 \text{ mL} - 50.0 \text{ mL} \\ &= 10.5 \text{ mL} \\ &= 10.5 \text{ cm}^3 \end{aligned}$$

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

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 Graduated 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 **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

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 (cm ³) | 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

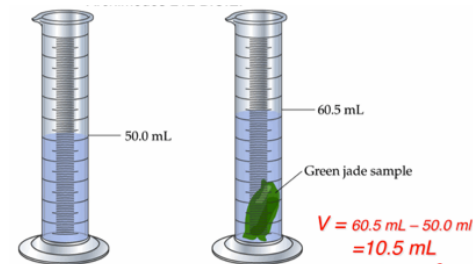
| Volume (cm ³) | Mass (g) |
|---------------------------|----------|
| 6.63 | 53.90 |
| 6.45 | 54.53 |
| 6.42 | 57.15 |
| 6.81 | 57.34 |
| 7.97 | 69.15 |
| 8.40 | 69.43 |
| 7.98 | 72.24 |
| 9.65 | 84.84 |
| 9.65 | 86.14 |
| 9.84 | 87.67 |

- 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.)
- 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.)
- The respective metals are either aluminum, density = 2.64 g/cm³ or copper, density = 8.94 g/cm³. 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?

Experiment #2 –Measuring Density

Complete and record all measurements

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

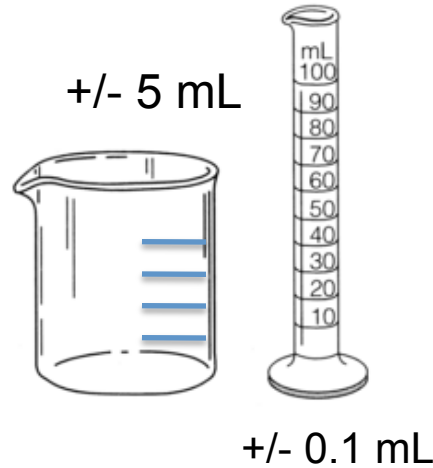
*Method 2: (2 Trials)
Pipet*

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.

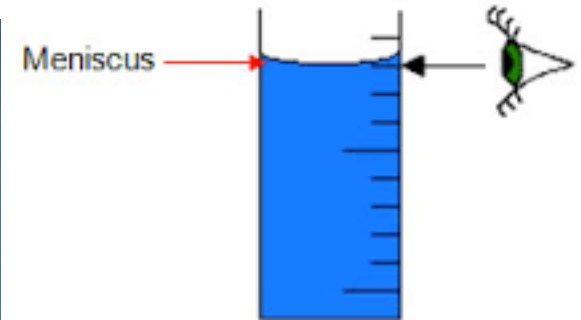
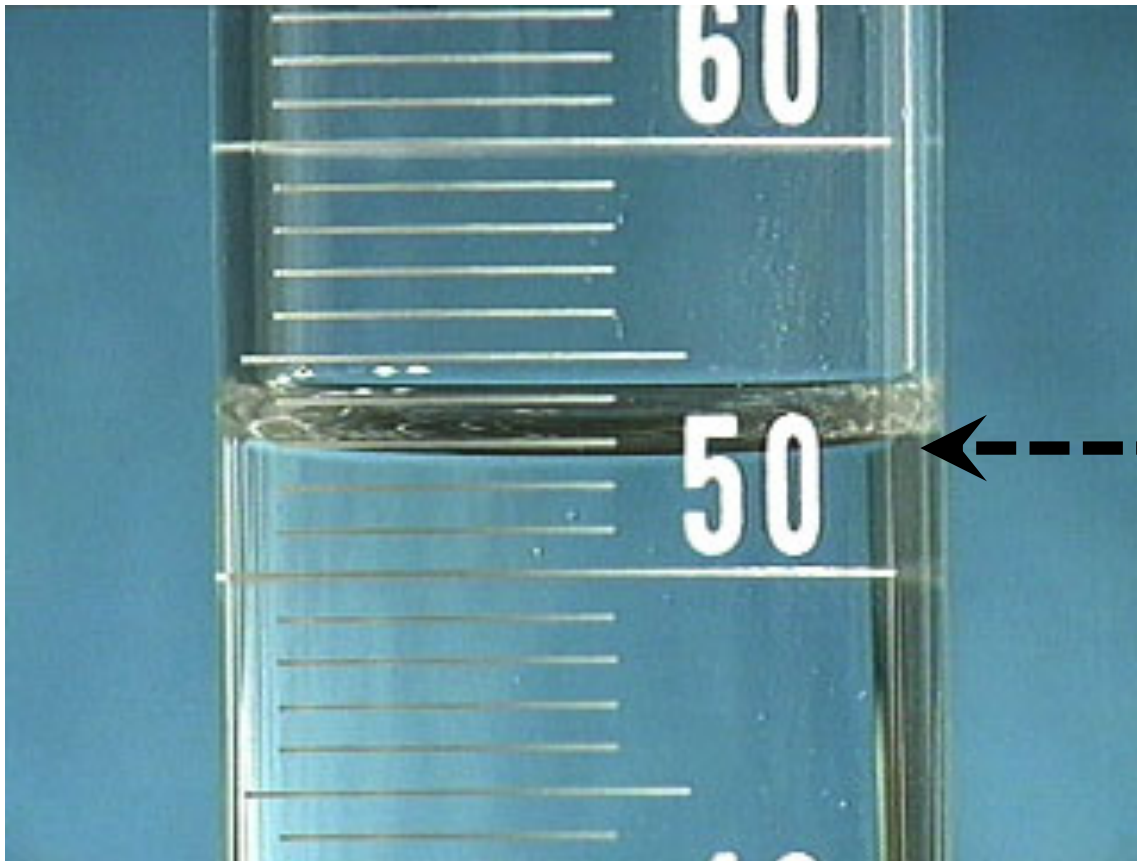
True

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

False

Reminder:

Measuring with a 100 mL Graduated Cylinder:

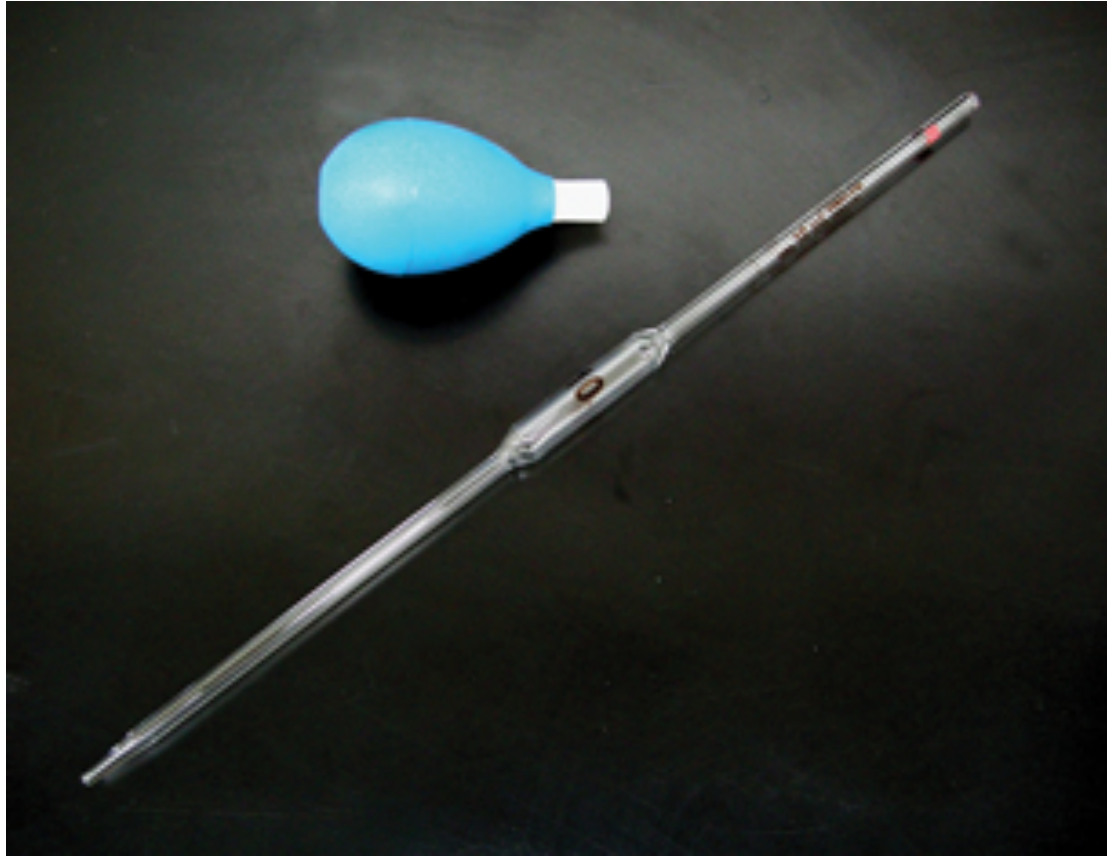


meniscus

*Measure
bottom of the
meniscus at
eye level*

52.9 mL

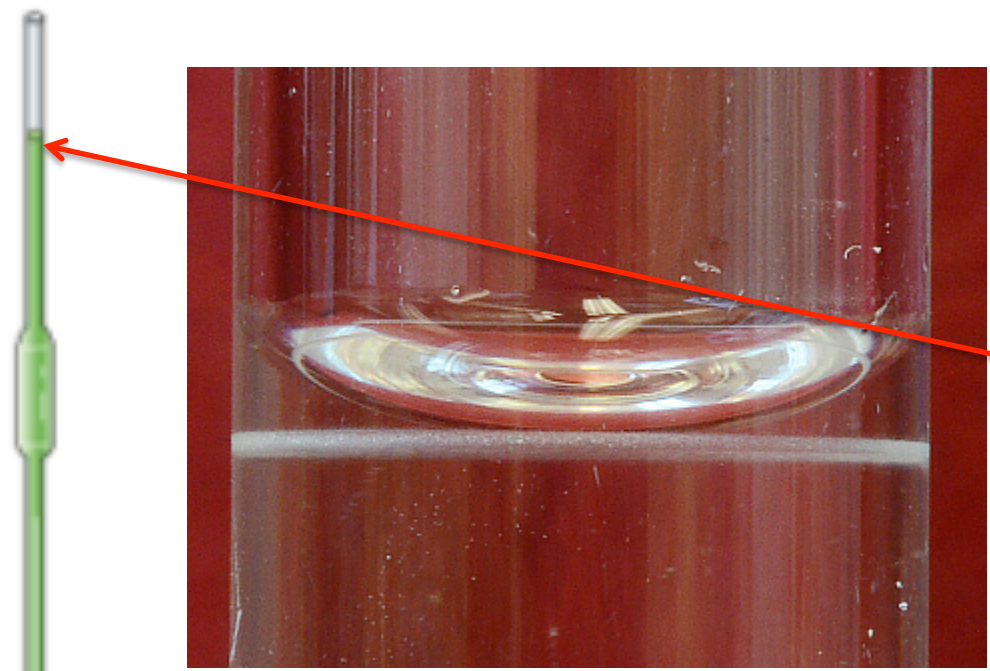
➤ Measurement using a volumetric pipet:



<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***

Volumetric pipet

Experiment #2 –Measuring Density

Complete and record all measurements

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



Part B–Density of a Solid UNKNOWN NUMBER **A or B**

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.

Method 1

Water Displacement (Grad. Cylinder)

Method 2

Water Displacement (Using Unk. Liq. Vial)

Method 3–Measuring Volume with Calipers

| | <i>Caliper</i> | <i>Ruler</i> |
|-----------------|----------------|--------------|
| Mass, metal | | |
| Height, metal | | |
| Diameter, metal | | |
| Radius, metal* | | |
| Volume, metal* | | |
| Density, metal* | | |

Method 3

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

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

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



Method 3-Measuring Volume with Calipers

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



➤ 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:

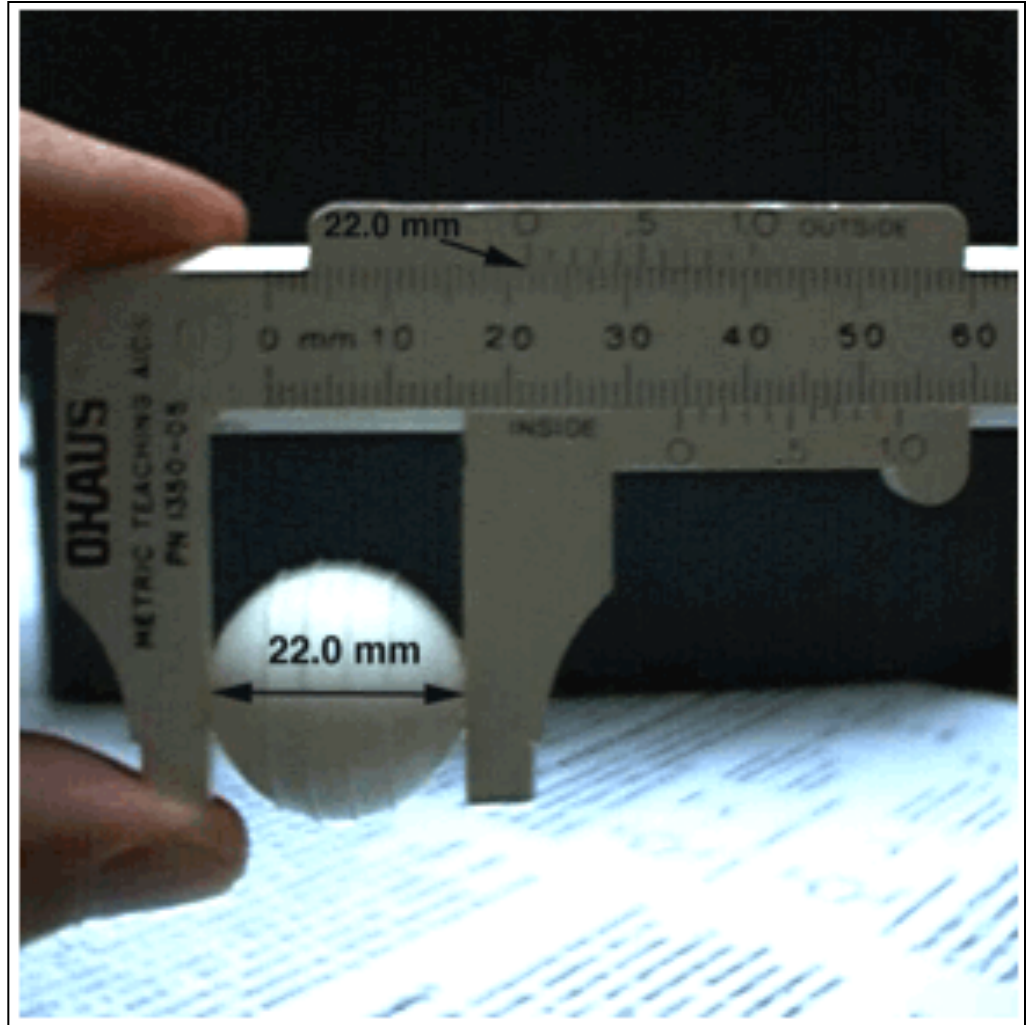
Part A - Average Density of Unknown Liquid from the two methods:

| | |
|---|--|
| 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.



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



Method 3—Volume by measurement with calipers

1. Use the calipers or rulers to measure in cm the diameter and height of the cylindrical metal unknown.
2. Using the formula for the volume of a cylinder ($V = \pi r^2h$), calculate the volume of the piece of metal.
3. Calculate the density of the metal.

Part C—Mass Versus Volume

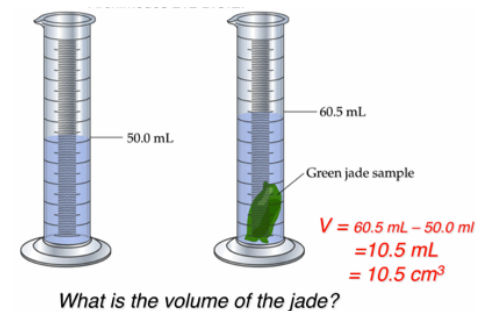
1. For each metal cylinder, measure and record its mass. Measure and record the diameter and height of each metal cylinder in cm.
2. Calculate the volume of the object ($V = \pi r^2h$). Make sure you write out the formula, write numbers and units in the formula, and write the answer with units and correct number of significant figures.
3. Repeat the above procedure with 2 different sized cylinders. Keep your three metal cylinders until the class data is graphed.
4. Obtain mass and volume data from the other members of your class. Be careful to keep pairs of data together.
5. Graph mass vs. volume (graph paper is in Appendix C). Plot mass on the vertical axis, and volume on the horizontal axis. Choose an appropriate scale so that you use most of the graph paper to plot your data. Label the axes, showing your units. Give the graph a title.
6. Draw lines on your graph to represent the mass–volume relations of each type of metal. Calculate the slope of each line. Be sure to include units. Extrapolate your lines through the y (vertical) axis.

**REPLACEMENT PAGE FOLLOWS
(HANDOUT)**

Measuring Density 19



Method 2:



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



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 (cm ³) | 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

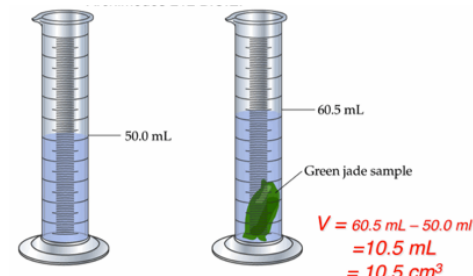
| Volume (cm ³) | Mass (g) |
|---------------------------|----------|
| 6.63 | 53.90 |
| 6.45 | 54.53 |
| 6.42 | 57.15 |
| 6.81 | 57.34 |
| 7.97 | 69.15 |
| 8.40 | 69.43 |
| 7.98 | 72.24 |
| 9.65 | 84.84 |
| 9.65 | 86.14 |
| 9.84 | 87.67 |

- 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.)
- 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.)
- The respective metals are either aluminum, density = 2.64 g/cm³ or copper, density = 8.94 g/cm³. 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:

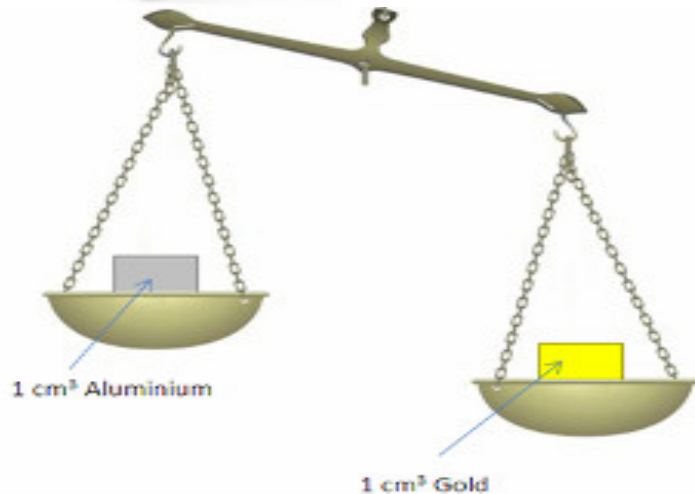


What is the volume of the jade?

Density

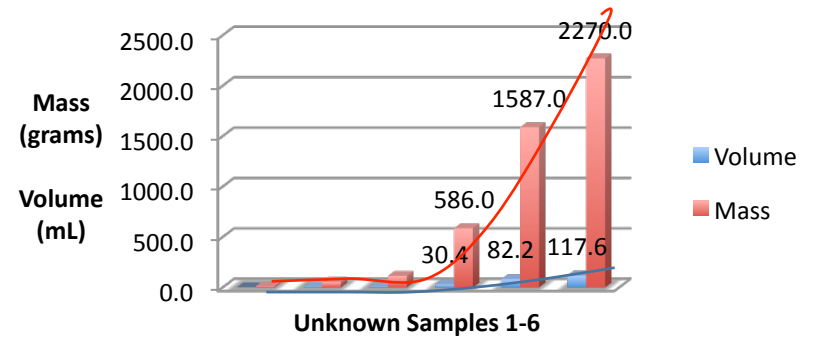
Mass & Volume

Numbers
Tables
Graphs

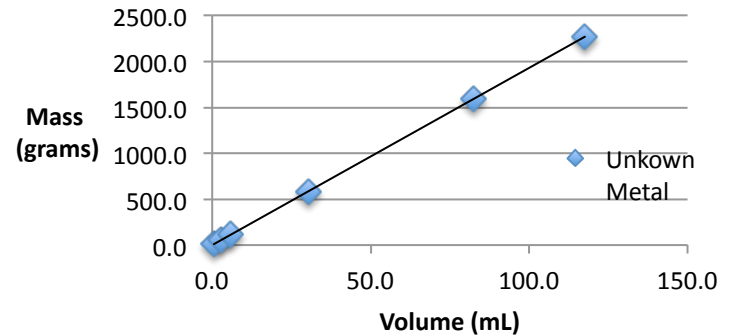


Metal

Mass & Volume



Density



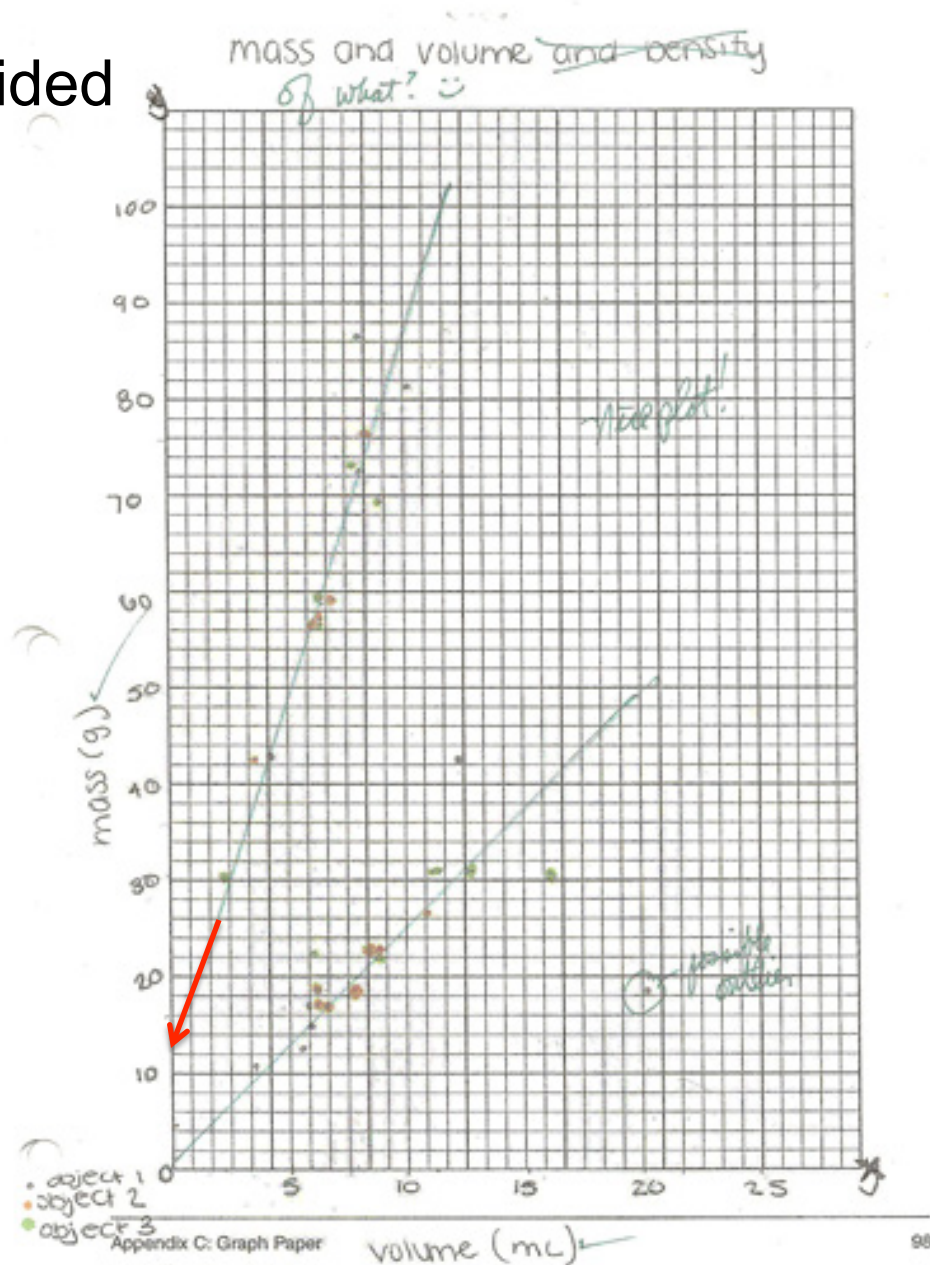
ables, & Graphs

- 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?

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

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

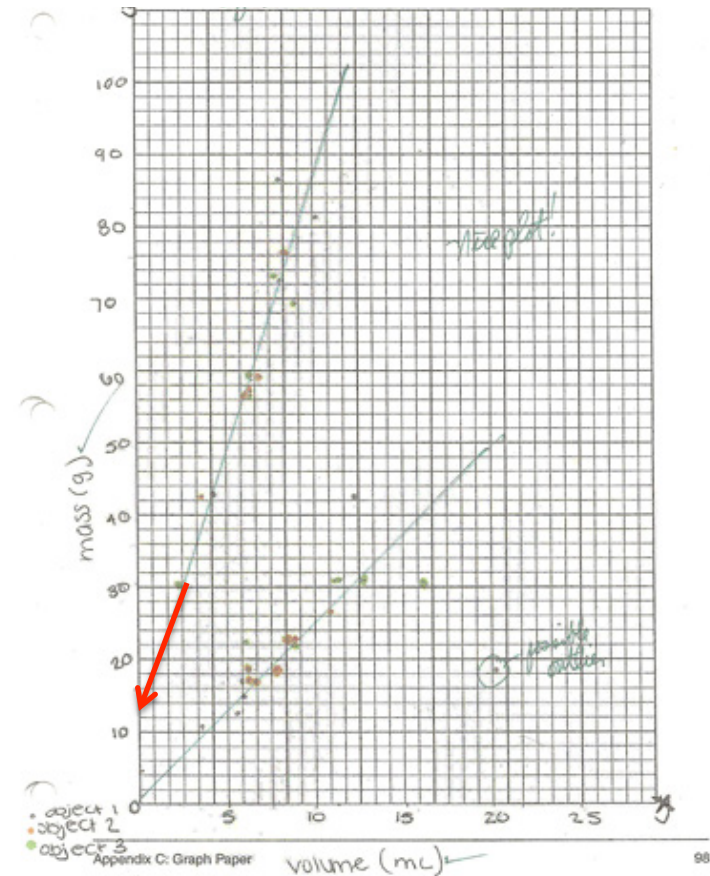
If we compare to equation of a line:

$$\begin{array}{ccccccc} \textit{mass} & = & \textit{density}(\textit{Volume}) & + & 0 \\ \Delta y & = & m & \Delta x & + b \end{array}$$

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

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 Graduated 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.

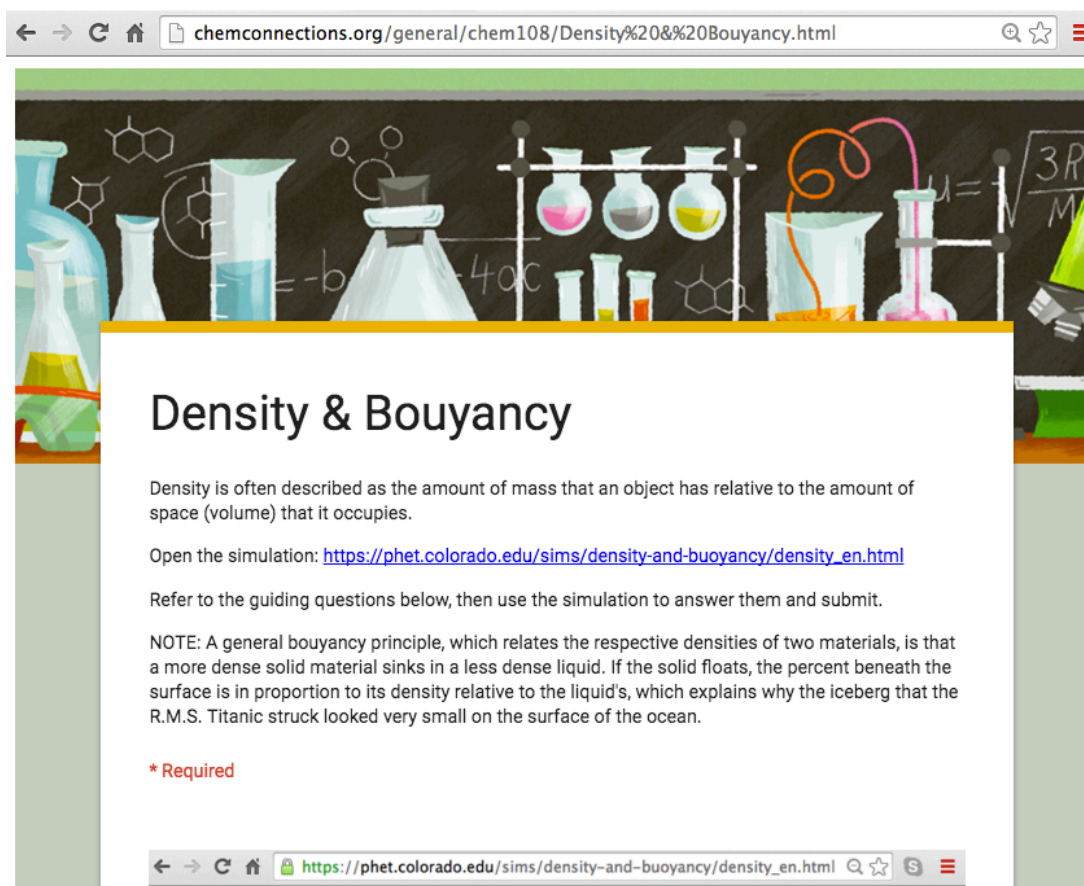
Have **individual** forms initialed before leaving lab today.

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&%20Bouyancy.html>



The screenshot shows a web browser window with the address bar containing the URL chemconnections.org/general/chem108/Density%20&%20Bouyancy.html. The page features a decorative header with various chemistry glassware and molecular structures. The main content area is titled "Density & Bouyancy" and contains the following text:

Density is often described as the amount of mass that an object has relative to the amount of space (volume) that it occupies.

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

Refer to the guiding questions below, then use the simulation to answer them and submit.

NOTE: A general buoyancy principle, which relates the respective densities of two materials, is that a more dense solid material sinks in a less dense liquid. If the solid floats, the percent beneath the surface is in proportion to its density relative to the liquid's, which explains why the iceberg that the R.M.S. Titanic struck looked very small on the surface of the ocean.

*** Required**

At the bottom of the page, there is a second browser window showing the URL https://phet.colorado.edu/sims/density-and-buoyancy/density_en.html.

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

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

My Block Material **Wood**

Mass kg

Volume L

Density **0.40 kg/L**

Blocks

- Custom
- Same Mass
- Same Volume
- Same Density
- Mystery

2.00 kg

102.00 L

About...

PHET

Reset All

Blocks

- Custom
- Same Mass
- Same Volume
- Same Density
- Mystery

Hide Table

0.00 kg

100.00 L

| Material | Density (kg/L) |
|----------|----------------|
| Wood | 0.40 |
| Apple | 0.64 |
| Gasoline | 0.70 |
| Ice | 0.92 |
| Water | 1.00 |
| Aluminum | 2.70 |

About...

PHET

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

- **DUE Week #5**

Equipment

From the stockroom

10.00 mL volumetric pipet

1 pipet bulb

~~set of metal cylinders for Part C~~

caliper ~~X~~ yellow cm ruler

plus

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.*

