

# Chem 108: Lab

Week 5

Sign in: Roster @ front of lab

Remember the LETTER next to your name on the roster.

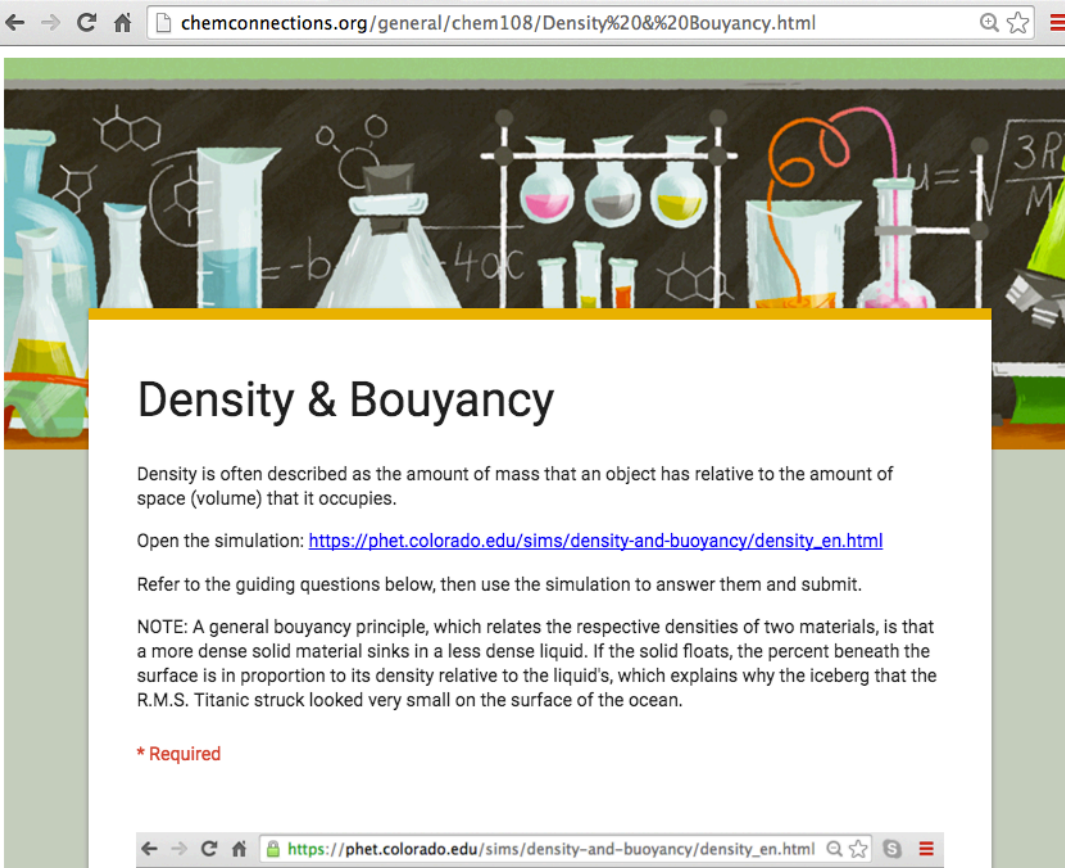
Pick up graded papers & handout

## *Due Today*

- Completed density calculations, graphs & Report Forms pp.20-25 (One form for each lab partner are to be turned in; stapled together. Neatest one on top.)
- Check significant figures and calculations carefully. Uncertainty (+/-) values are not to be included, but measurement data must be correct relative to the experimental equipment used. Review returned Measurement Reports.
- (GQ) On-line *Density & Buoyancy Guiding Questions* (individually done)

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

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



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

## Density & Bouyancy

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](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.

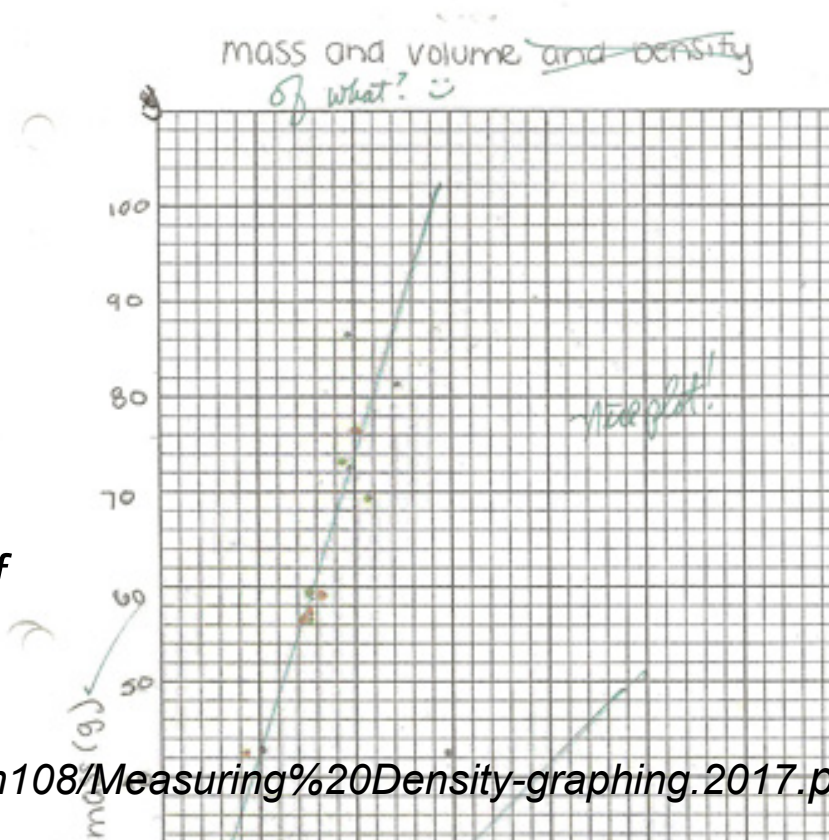
**\* Required**

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

➤ Plot of data (A) & (B) using blank graph paper

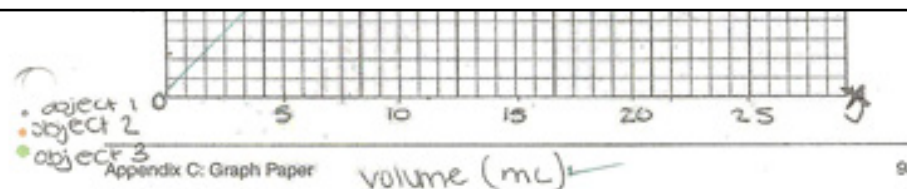
- Either (A) & (B) on the same graph paper or separate pages.
- Attach graph(s) to the combined Report Form pages
- *Complete the bottom table of handout and attach to the Report Forms to turn in.*

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



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

- Anyone plot the data using a spreadsheet?



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

$y = y$  axis     $m = \text{slope}$      $x = x$  axis     $b = y\text{-intercept}$

We're plotting:     $\text{Mass} = y$  axis     $\text{Volume} = x$  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:

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

Now, what does the slope of our trendline represent?

(Comparing the  $x, y$  values of any 2 points on the trendline.)

# Using a Spreadsheet (Excel)

Density

Volume (cm<sup>3</sup>)

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

AVG

Density



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Volume (cm<sup>3</sup>)

Mass (g)

7.89

17.22

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11.7

29.69

AVG

9.53

24.05

Density

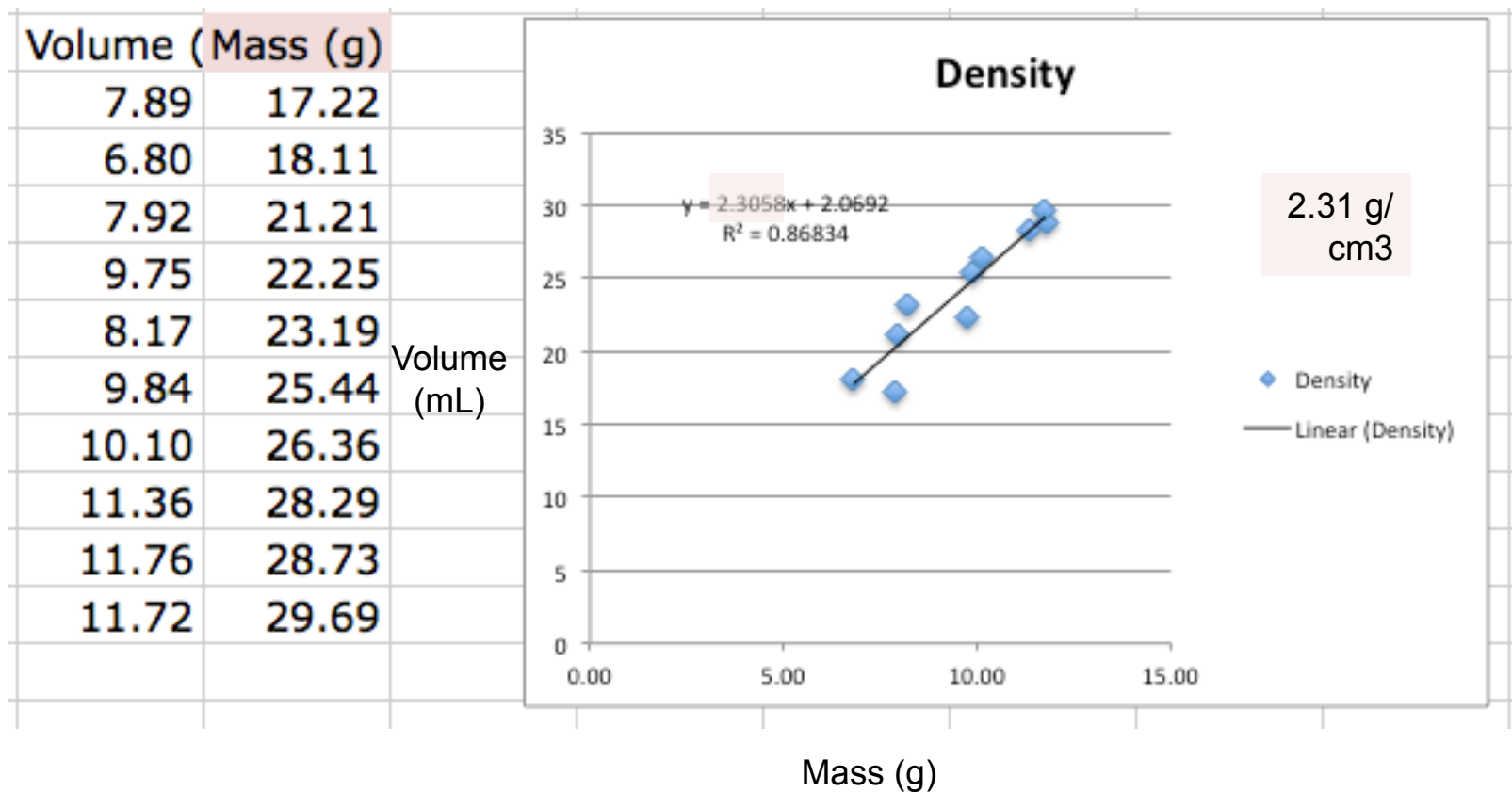
2.52

g/cm<sup>3</sup>

# Using a Spreadsheet (Excel)

## *Youtube*

<https://www.youtube.com/watch?v=3kNEv3s8TuA>





# Using a Spreadsheet (Excel)

## *Youtube*

<https://www.youtube.com/watch?v=3kNEv3s8TuA>

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

A

Metal identified	Al = 2.64 g/cm <sup>3</sup>
Density (g/cm <sup>3</sup> ) averaged	2.52 g/cm <sup>3</sup> +/-0.19
Error (%) averaged	(2.52-2.64)/2.64 * 100= 4.5%
Density (g/cm <sup>3</sup> ) graphed	2.31 g/cm <sup>3</sup> +/-0.12
Error (%) graphed	(2.31-2.64)/2.64 * 100= 12.5%

Linear Regression straight lines improve precision.  
They do not necessarily improve accuracy.

# MOOCs: “Free” Courses

<https://www.edx.org/course/analyzing-visualizing-data-excel-microsoft-dat206x-4>

## Learning to Use a Spreadsheet (Excel)

EdX

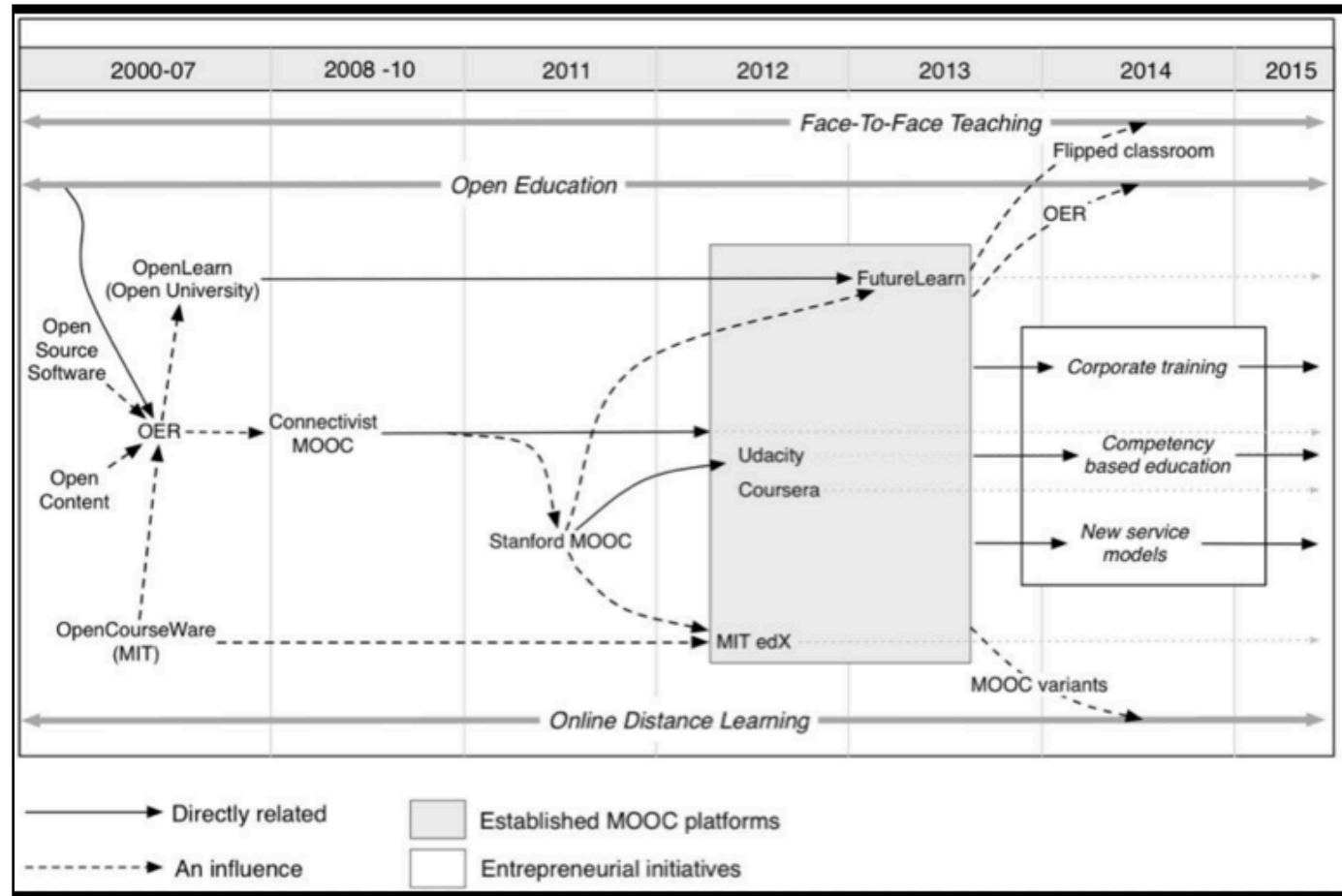
Coursera

Udacity

The screenshot shows the EdX course page for 'Analyzing and Visualizing Data with Excel'. The browser address bar displays the URL: <https://www.edx.org/course/analyzing-visualizing-data-excel-microsoft-dat206x-4>. The page features a navigation breadcrumb: Home > All Subjects > Data Analysis & Statistics > Analyzing and Visualizing Data with Excel. A main header section includes a video player thumbnail, the course title 'Analyzing and Visualizing Data with Excel', a brief description, and a Microsoft logo. To the right, there are links for 'Sign In' and 'Register', a 'Self-Paced' label, and a green 'Enroll Now' button. Below the main header, the 'About this course' section states it is part of the 'Microsoft Professional Program Certificate in Data Science' and includes a 'See more' link. The 'What you'll learn' section lists four bullet points: 'Gather and transform data from multiple sources', 'Discover and combine data in mashups', 'Learn about data model creation', and 'Explore, analyze, and visualize data'. A 'View Course Syllabus' link is provided. The 'Meet the instructors' section features two profiles: Dany Hoter, Senior Program Manager at the Excel team, and Jonathan Sanito, Senior Content Developer at Microsoft. At the bottom, a section titled 'Pursue a Verified Certificate to highlight the knowledge and skills you gain (\$49)' includes an 'Official and Verified' badge and an 'edX' logo. On the right side of the page, a sidebar lists course details: Length (6 weeks), Effort (2-4 hours per week), Price (FREE, with an option to add a Verified Certificate for \$49), Institution (Microsoft), Subject (Data Analysis & Statistics), Level (Intermediate), and Languages (English). A 'Video' icon is also present at the bottom of the sidebar.

# MOOCs: “Free” Courses

EdX  
Coursera  
Udacity



# QUESTION

Rank the correct relative precision of the results from the two methods for Metal A's density's calculation. It's accepted density is  $2.64 \text{ g/cm}^3$

<i>Density</i>		<i>Density</i>
Data Averaging		Linear Regression Straight Line
$2.52 \text{ g/cm}^3$ $\pm 0.19$		$2.31 \text{ g/cm}^3$ $\pm 0.12$

A) Precision: Straight Line > Averaging

B) Precision: Averaging > Straight Line

# QUESTION

Rank the correct relative accuracy of the results from the two methods for Metal A's density's calculation. It's accepted density is  $2.64 \text{ g/cm}^3$

<i>Density</i>		<i>Density</i>
Data Averaging		Linear Regression Straight Line
$2.52 \text{ g/cm}^3$ $\pm 0.19$		$2.31 \text{ g/cm}^3$ $\pm 0.12$

A) Accuracy: Straight Line > Averaging

B) Accuracy: Averaging > Straight Line

# Worksheet: Handout



## Experimentation:

- Complete *Measuring Density* calculations, graphs & Report Form pp.20-25 (One form for each lab partner to be turned in.) DUE Today
- (GQ) Density *Guiding Questions* DUE Today
- WORKSHEET (HANDOUT pdf): Precision, Accuracy & Periodicity, DUE Today (Turn in before leaving lab)

Adapted from *Workshop Chemistry*

Name(s) \_\_\_\_\_

## *Precision, Accuracy & Periodicity*

1) Two students report the following data for the density of an unknown metal:

	Student 1	Deviation	Student 2	Deviation
Trial 1	22.0 g/cm <sup>3</sup>	+0.1	23.0 g/cm <sup>3</sup>	+1.1
Trial 2	21.8 g/cm <sup>3</sup>	-0.1	21.0 g/cm <sup>3</sup>	-0.9
Trial 3	22.0 g/cm <sup>3</sup>	+0.1	21.3 g/cm <sup>3</sup>	-0.6
Trial 4	21.8 g/cm <sup>3</sup>	-0.1	22.3 g/cm <sup>3</sup>	+0.4
Average	21.9 g/cm <sup>3</sup>	+/- 0.1	21.9 g/cm <sup>3</sup>	+/- 0.8

- The accepted value is 21.8 g/cm<sup>3</sup>.
  - The error is 0.4% in both cases:  $(21.9 - 21.8)/21.8 \times 100 = 0.4\%$
- Should both students receive the same grade? Explain your answer.

2) In the early 1870's, Mendeleev predicted three "new" elements, their atomic masses and their densities: "Ekaboron", atomic mass = 44; "Ekaaluminium", atomic mass = 68, density = 5.9 g/cm<sup>3</sup> and "Eksilicon", atomic mass = 72, density = 5.5 g/cm<sup>3</sup>.

a) Identify the three elements by their modern names from their masses and relative locations in the periodic table.

Ekaboron =

Ekaaluminium =

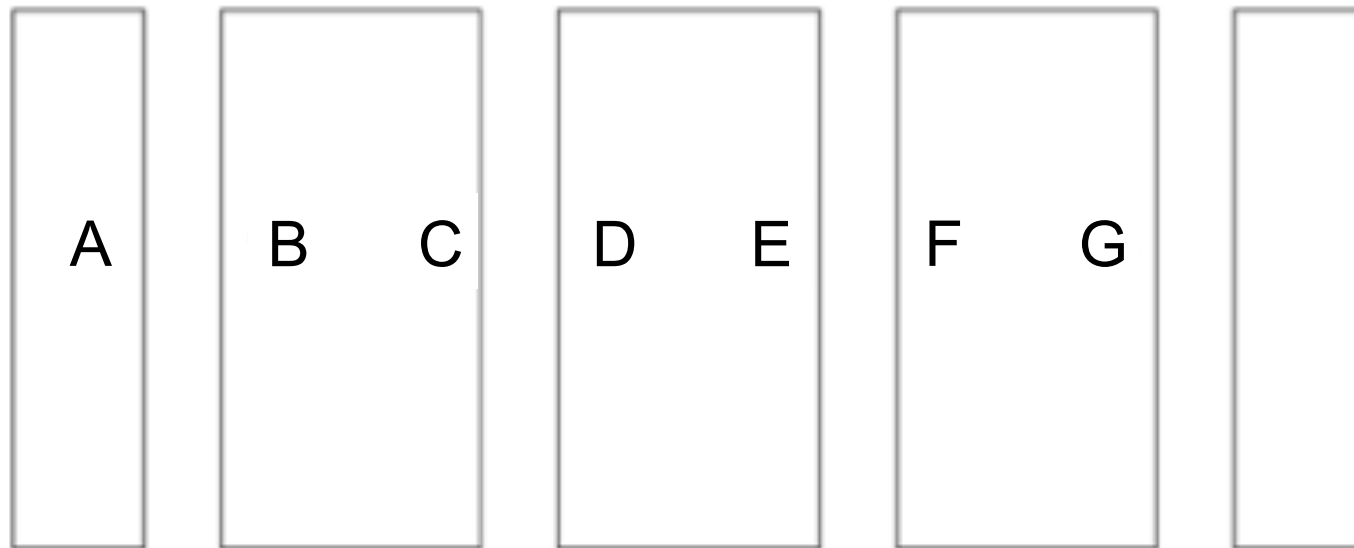
Eksilicon =



# Experiment 3: Classification of Matter and Chemical Change

*Move to the lab location that matches your  
roster letter with the map letter*

**Front of Lab**





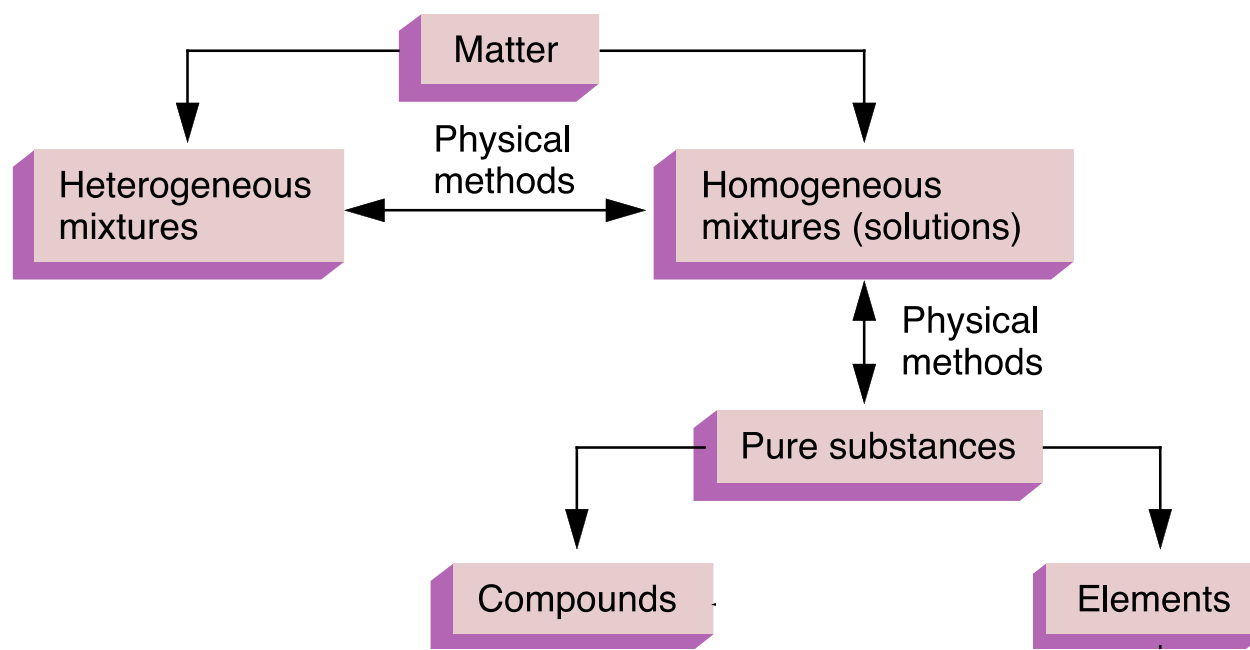
# *CHEM 108*

## Experiment 3: Classification of Matter and Chemical Change

*refer to calendar link:*

[http://www.chemconnections.org/general/chem108/Phys  
%20Properties-Separations%202017.htm](http://www.chemconnections.org/general/chem108/Phys%20Properties-Separations%202017.htm)

- Write yours and all partners' names **ON all REPORT FORMS**, pp. 5-8, **DUE Next Week**



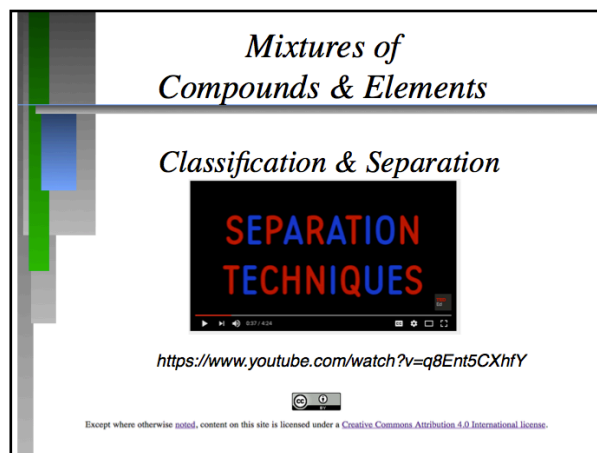
# Classifying & Separating Matter

## Mixtures → Pure Substances

# Classification of Matter and Chemical Change

*Refer to the calendar link:*

[http://www.chemconnections.org/general/chem108/Phys  
%20Properties-Separations%202017.htm](http://www.chemconnections.org/general/chem108/Phys%20Properties-Separations%202017.htm)



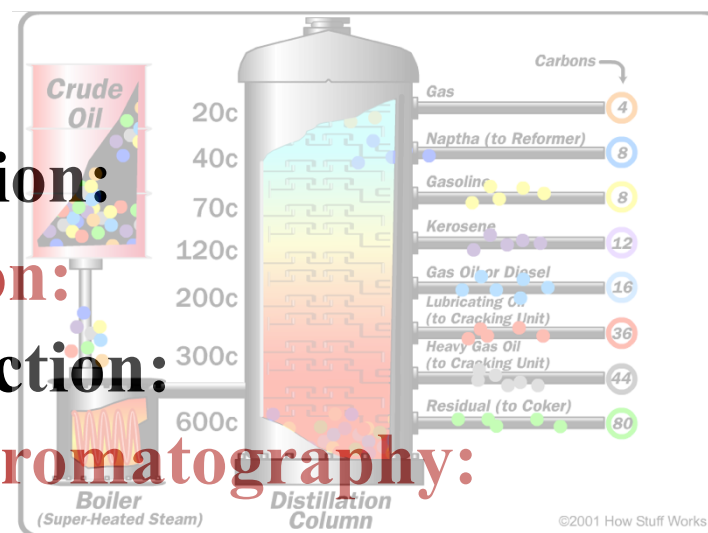
**Filtration:**

**Crystallization:**

**Distillation:**

**Extraction:**

**Chromatography:**



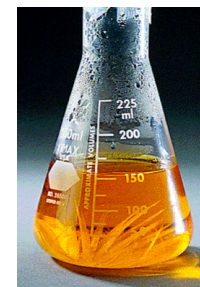
# Separating Mixtures

• **Filtration:** Separation of components in a mixture based upon **differences in particle size**. **Examples:** particles from air, coffee from grounds.



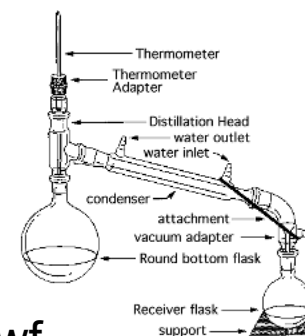
• **Crystallization:**

Separation based upon **differences in solubility** of components in a mixture. **Example:** rock candy



• **Distillation:**

Separation based upon **differences in boiling** of components in a homogeneous mixture. **Example:** gasoline from crude oil

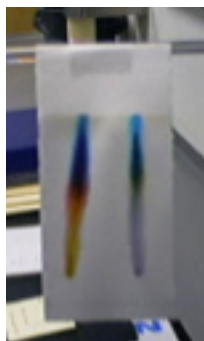


# Separating Mixtures

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- **Extraction:** Separation based upon differences in a compound's solubility between two different solvents, typically immiscible liquids. **Examples:** gasoline (hydrocarbons) and water.



- **(Chemical Separation) Chromatography:** Separation based upon differences a compound's solubility in a solvent versus a stationary phase. **Examples:** paper chromatography, thin layer (TLC), column, gas-liquid (GC); liquid-liquid: (HPLC), reverse phase.

# Classification of Matter and Chemical Change

## ➤ Goals:

- Part A: To classify a pure substance as a homogeneous or heterogeneous mixture and quantify the mixture's components
- Part B: To classify a material as a pure substance or mixture based on observation
- Part C: Using Paper Chromatography to classify inks as pure substances or homogeneous mixtures
- Part D: Determining if chemical changes occur.

## ➤ Work with your partners

- Be sure to write partner's name ON ALL REPORT FORMS

# Classification of Matter

## Part A: Procedural Scheme

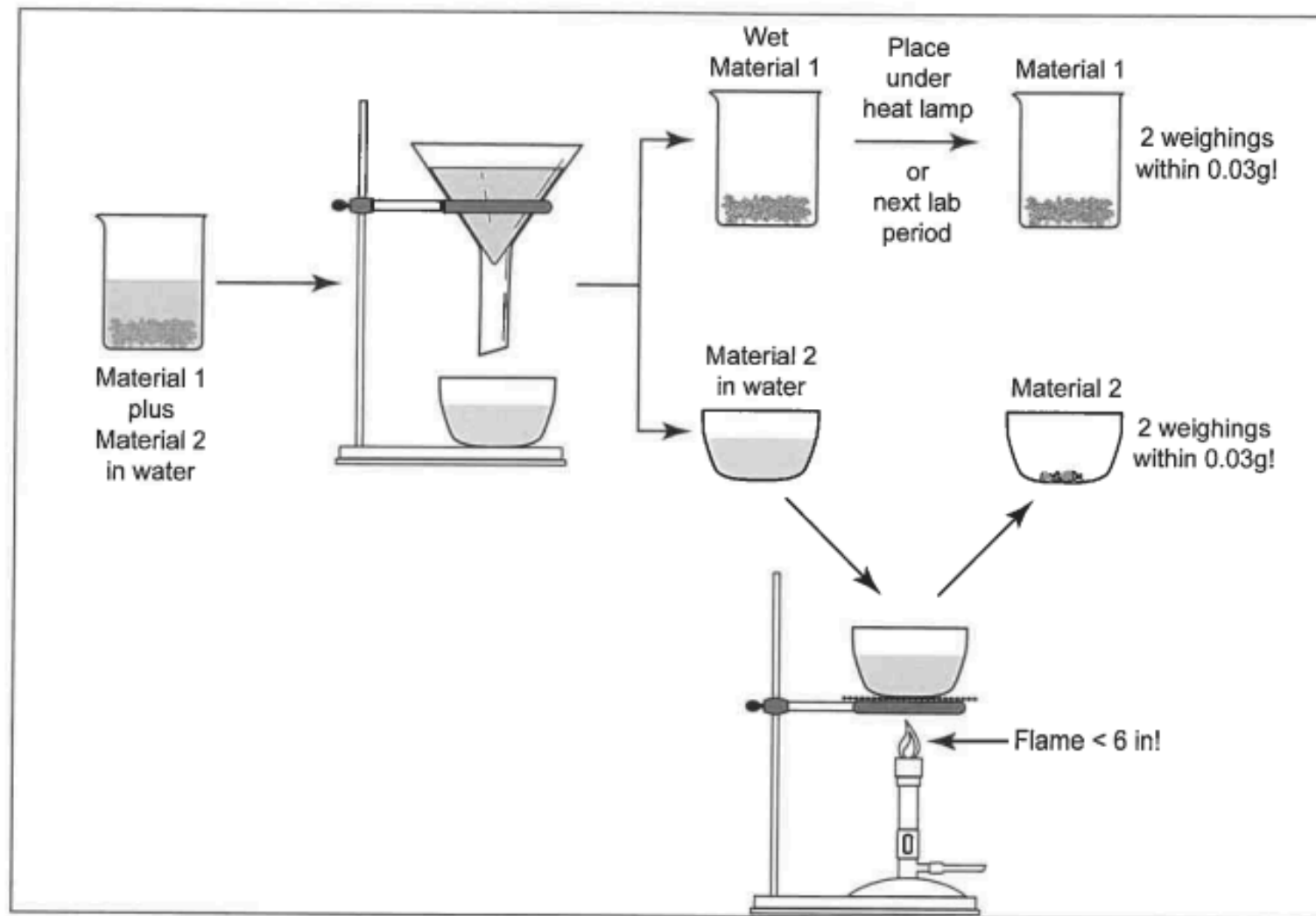


Figure 1—Overview of Part A

# Classification of Matter and Chemical Change

## Measuring solids (Part A):

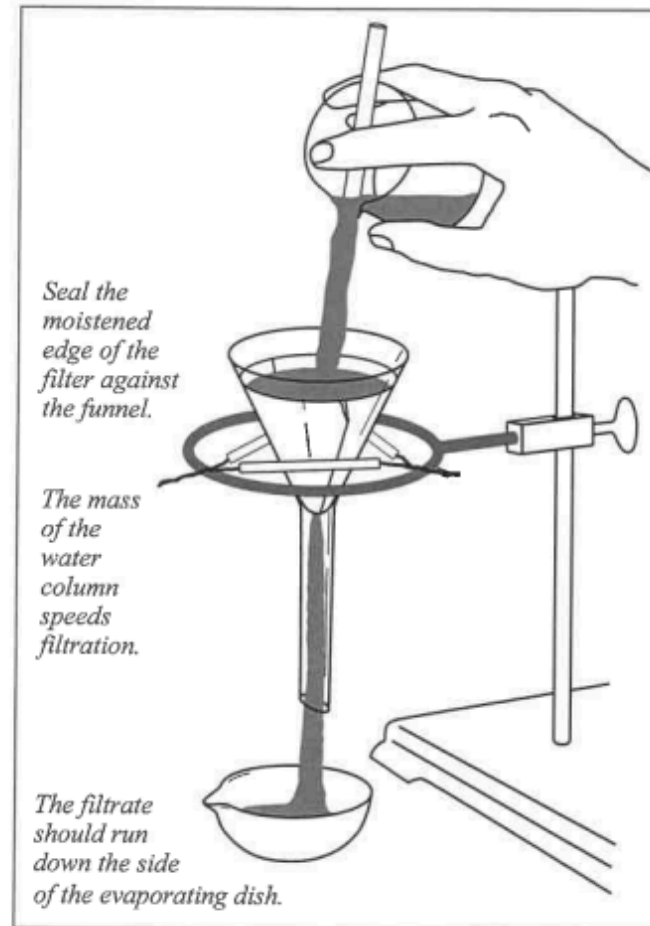
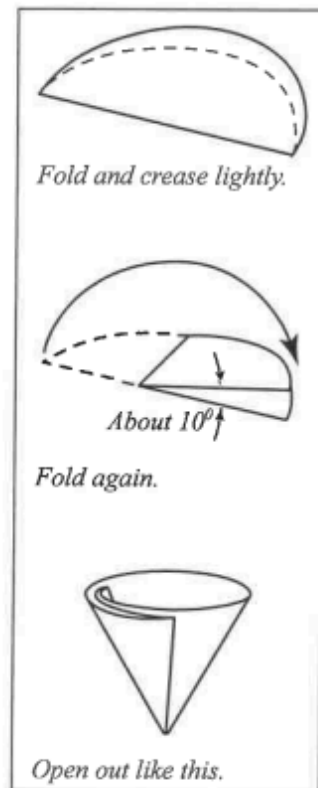
- 1) Weigh empty container (beaker) & record mass
- 2) Remove beaker from balance and pour solid into the beaker
- 3) Place the beaker with the solid back on the balance & record mass

**DO NOT** pour any materials/ chemical into containers while on balance pan; clean area and balance of any loose /spilled materials/ chemicals before leaving, close all bottles



# Classification of Matter

## Filtration

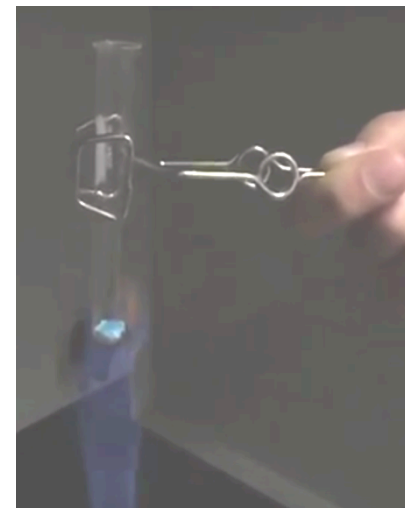


## Part A

- Use a minimal amount of  $\text{H}_2\text{O}$  when transferring solids from beaker into filter; too much causes evaporation time to be VERY long
- PROCEDURE to note & follow:
  - Boil filtrate *gently* until no drops are observed on watch glass
    - If boiled too rapidly, crystals collect on watch glass
    - **SAFETY TIP: Hot evaporating dish will shatter if placed on cold lab bench – Allow to cool on grating before placing on bench**
  - DO NOT dry Material 1 and filter paper under heat lamp. Store in your lab drawer covered by paper towel . . . by the next lab session, they will be *very* dry
- WASTE: **(next lab session)**
  - Filter paper and Material 1 in trash
  - Material 2 in sink with  $\text{H}_2\text{O}$  running

## Part B: $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

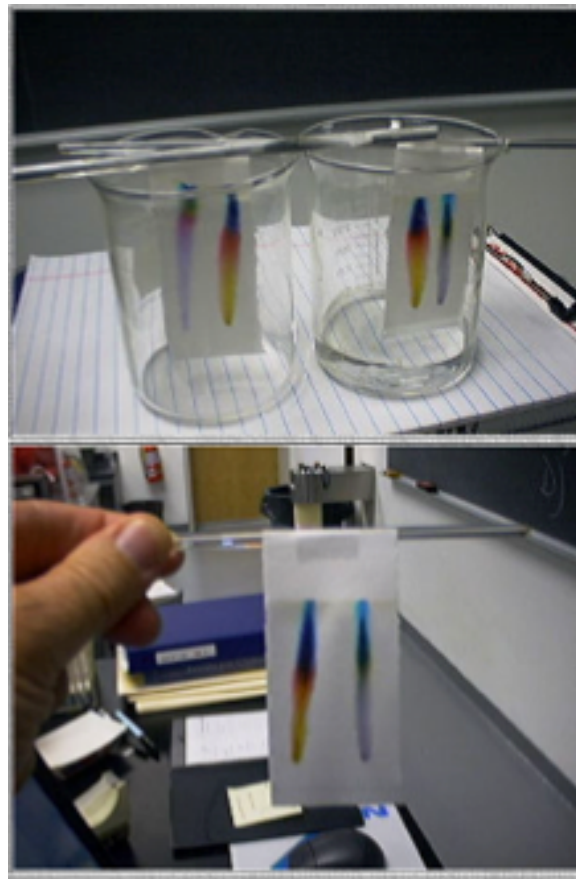
- Copper(II) sulfate pentahydrate
  - *May be labeled cupric sulfate pentahydrate*
- Heat the hydrate *gently* in a test tube
- Waste:
  - Add in minimum amount of  $\text{H}_2\text{O}$  and stir to dissolve all solid
  - Pour solution into red “Aqueous Metal Waste” container in hood
  - Be sure to record “color” and/or “clarity” **BEFORE** discarding any solutions or chemicals



e.g.) *solution: blue and cloudy, solution: colorless and clear, solid: white*

# Classification of Matter

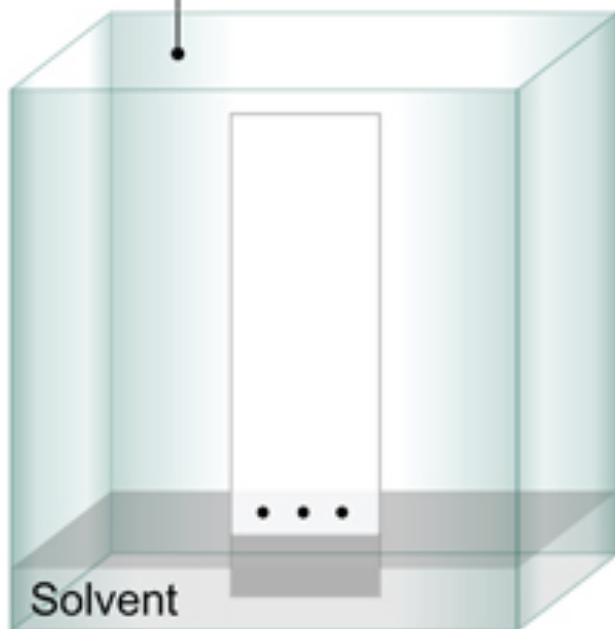
## Part C – Paper Chromatography)



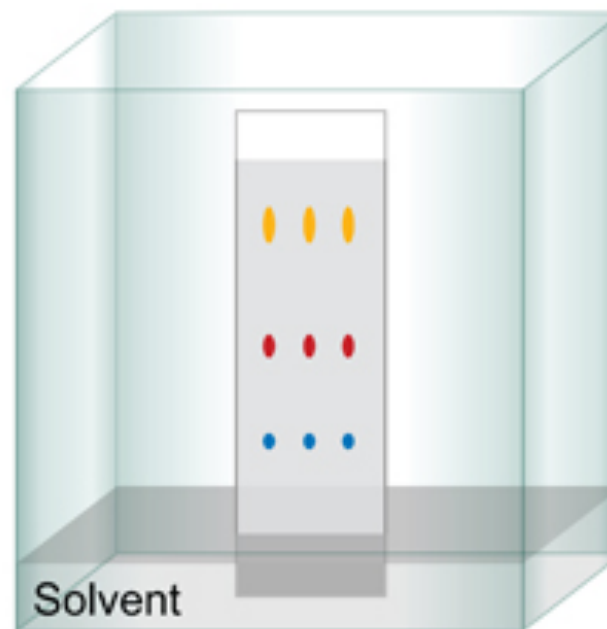
## Part C – Paper Chromatography

- Use water-soluble pens that are provided, DO NOT use your own pen
  - DO NOT use permanent pens/markers

Beaker with pure water as solvent



Time Zero



After Ten Minutes

- Waste: paper in trash; water in sink

- PROCEDURE: Before starting Part D, dispense 3-4mL of 6M NaOH and 3-4mL of 6M HCl into separate test tubes: *6M means 6 Molar = 6 mol/L; Molarity is an important unit of concentration*

Take to YOUR LAB BENCH for Parts D.1 and D.3

- Avoid spilling NaOH or HCl
- If spilled, neutralize with solid  $\text{NaHCO}_3$  (sodium bicarbonate) from bucket, then wipe with paper towel
  - An acid + base react to produce a salt and water
- Waste for D.1:
- Pour all solutions into  $\text{NaHCO}_3$  in hood sink with  $\text{H}_2\text{O}$  running

## Part D.2:

### ➤ Waste for D.2:

- Into red “Aqueous Metal Waste” container in hood

## Part D.3:

- *20 drops HCl  $\approx$  1mL, add “dropwise”*

### ➤ Waste for D.3:

- Into NaHCO<sub>3</sub> in hood sink with H<sub>2</sub>O running

## Part D.4:

### ➤ Waste for D.4:

- Into red “Aqueous Metal Waste” container in hood

## Exp. 3 – Classification of Matter and Chemical Change

DUE Next Lab Period

- Report Forms: *One form for each lab partner are to be turned in; stapled together. Neatest one on top.*
  - Check sig figs are correct and units included
  - Show example of each type of calculation
  - Answer questions legibly in complete sentences.

DUE Next Lab Period



Individually complete  
on-line post-lab  
questions and  
submit on-line:

[http://www.chemconnections.org/  
general/chem108/Physical  
%20Properties.html](http://www.chemconnections.org/general/chem108/Physical%20Properties.html)

### Physical Properties

Refer to the reading:  
<http://chemconnections.org/general/chem106/Investigating%20Physical%20Properties.1.pdf>  
Provide answers to the following questions.

**\* Required**

**Name: Last, First \***

Your answer \_\_\_\_\_

**DVC id \***

Your answer \_\_\_\_\_


**Lab Section \***

☐ Monday

☐ Wednesday

**e-mail address \***

Your answer \_\_\_\_\_

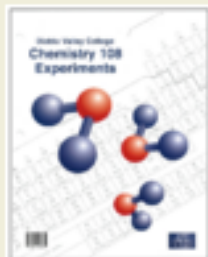


1. A mixture of sand and sawdust contains 124 g of sand and 305 g of sawdust. Find the mass percent of each component in this mixture. \*

Provide % sand and % sawdust.

Your answer \_\_\_\_\_

**DUE Next Lab Period**



**Due Today**

Experimentation:

- Complete *Measuring Density* calculations, graphs & Report Form pp.20-25 (One form for each lab partner to be turned in.) **DUE Today**
- (GQ) *Density Guiding Questions* **DUE Today**
- **WORKSHEET** (HANDOUT pdf): Precision, Accuracy & Periodicity, **DUE Today** (Turn in before leaving lab)

Complete Worksheet in collaboration with your assigned group partners and turn in one form for entire group before leaving lab. **Due Today**

## Worksheet: Handout

Adapted from *Workshop Chemistry*

Name(s) \_\_\_\_\_

### *Precision, Accuracy & Periodicity*

1) Two students report the following data for the density of an unknown metal:

	Student 1	Deviation	Student 2	Deviation
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Trial 2	21.8 g/cm <sup>3</sup>	-0.1	21.0 g/cm <sup>3</sup>	-0.9
Trial 3	22.0 g/cm <sup>3</sup>	+0.1	21.3 g/cm <sup>3</sup>	-0.6
Trial 4	21.8 g/cm <sup>3</sup>	-0.1	22.3 g/cm <sup>3</sup>	+0.4
Average	21.9 g/cm <sup>3</sup>	+/- 0.1	21.9 g/cm <sup>3</sup>	+/- 0.8

- The accepted value is 21.8 g/cm<sup>3</sup>.

- The error is 0.4% in both cases:  $(21.9 - 21.8)/21.8 \times 100 = 0.4\%$

Should both students receive the same grade? Explain your answer.

2) In the early 1870's, Mendeleev predicted three "new" elements, their atomic masses and their densities: "Ekaboron", atomic mass = 44; "Ekaaluminium", atomic mass = 68, density = 5.9 g/cm<sup>3</sup> and "Ekasilicon", atomic mass = 72, density = 5.5 g/cm<sup>3</sup>.

a) Identify the three elements by their modern names from their masses and relative locations in the periodic table.

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