Module 1; Density of Liquids

Directions: Answer all questions in this text document. Submit your document to be graded. You may print out this document, then hand write and scan. OR you can word process directly on this document.

Introduction and Pre-Lab Exercises

Multiple trials, averages, ranges, % errors

Most chemistry experiments involve some type of measurement. The reliability and reproducibility of the experiments depends on the accuracy and precision of the measurements taken. **Accuracy** is how close the results are to the actual value. **Precision** is how close the results are to each other.

In most experiments, multiple trials are run to check for precision and to improve accuracy. An **average** value of the trials is determined by adding up all the values and dividing by the number of trials. The **range** of the values is determined by subtracting the lowest value from the highest value.

Measurements are most precise when their range is the smallest; that means all the values were clustered near each other and were fairly reproducible. In addition, the more significant figures available, the more precise the measurement is.

1. Three students measured the distance across a room with meter sticks. They each did the measurement 3 times. The accepted value for the measurement is 435.0 cm. Complete the table and answer the questions below:

	Trial 1	Trial 2	Trial 3	Average (unit)	Range (unit)
Student A	448.0 cm	485.6 cm	463.4 cm		
Student B	450.5 cm	441.3 cm	446.8 cm		
Student C	422.6 cm	445.2 cm	432.7 cm		

2. Which student had the most accurate measurements?

3. Which student had the most precise measurements?

4. What is the uncertainty in this measurement?

5. Using the data above, calculate the percent error for Student C, Trial #1. Round your answer off to three significant figures. The formula is provided here:

$$\text{percent error} = \left(\frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \right) \times 100$$

Procedures and Data

Use the following link to access an online simulation. I suggest you use a split screen so that you can follow directions while running the experiment.

Simulation Link: http://chemcollective.org/activities/vlab/69

TRIAL #1: 12.0 mL of Compound A-1.

1. Click on "Solutions". Then select Compound A-1 by clicking on the + sign. Your solutions will appear on your workbench. (If you don't see "solutions", click on + by stockroom first.)
2. Click on + by Stockroom. Click on "Glassware". Click on Graduated Cylinders. Then select 25 mL Graduated Cylinder by clicking on the + sign. Your graduated cylinder will appear on your workbench.
3. Click on "Tools". Then select Scale by clicking on the + sign. Your scale will appear on your workbench.
4. Do step 1 as follows to measure the mass of a graduated cylinder.
   - Drag the scale to the bottom of your window.
   - Click on Tare to ensure the scale says 0.0000g.
   - Drag the graduated cylinder to cover the scale and then release. You should now see numbers on the scale.
   - Record the mass of your empty graduated cylinder.
5. Do steps as follows to Pour Compound A-1 into your graduated cylinder to measure the volume of your liquid.
   - Drag the Erlenmeyer flask with Compound A-1 to cover the graduated cylinder.
   - You should now have a window for entering desired volume.
   - Click on precise.
   - Enter a volume of 12.0 mL.
   - Click on pour.
   - Look at the bottom of the meniscus. It looks like it is right on the 12 mark, so you can use a zero for the estimated digit. Record the volume as 12.0 mL. (Note: the simulation tells you that 12.00 mL is transferred, but your graduated cylinder does not confirm that; it is only precise enough to show 12.0 mL.)
6. Determine the Mass of your Liquid.
   - After you poured 12.0 mL into your graduated cylinder, the mass should have gone up. Record that mass.
   - Now you can calculate the mass of the liquid by doing a subtraction.
7. Finally, calculate the density of the Liquid. Use the density formula, $D = M/V$.

TRIAL #2: 18.5 mL of Compound A-1.

1. Right-click on "workbench 1" and then select "clear workbench".
2. For Trial #2, move Compound A-1, a 25 mL graduated cylinder and a scale to your workbench as you did above.
3. Weigh the empty 25-mL Graduated cylinder as above.
4. This time put 18.5 ml of Compound A-1 into your graduated cylinder. Notice that the bottom of the meniscus is between the 18 mark and the 19 mark. If it looks halfway between, your estimated digit would be a 5. Record the value as 18.5 mL.
5. Record the mass of the graduated cylinder with Compound A-1.
6. Calculate density.

TRIAL #3: 42.8 mL of Compound A-1

For this trial, use 42.8 mL of Compound A. You will need to select a 50 mL graduated cylinder to do this. Notice that the meniscus for 42.8 mL sits right below the 43 mL mark.

Density of Liquids Data Table (Don't forget to include units on all numbers in data and calculations.)

		Trial 1:	**Trial 2:**	**Trial 3:**
Mass of empty graduated cylinder	Make sure to record all the numbers the scale provides, even the zeroes.			
Volume of liquid	Read from cylinder. Don't forget to include ONE estimated digit between the dashes. .			
Mass of graduated cylinder and liquid	The mass here should be higher than the mass of the empty graduated cylinder.			
	Show calculations below for trial 1 only.			
Mass of liquid	This is a calculation. Show the subtraction for trial #1. Keep sig.figs. to the same decimal place as the scale provided.			
Density	Show the formula D=M/V. Plug in the numbers with units. Solve. Round off to three sig.figs (like your volume measurements).			

1. Compare the density you found for 12.0 mL, 18.5 mL and 42.8 mL of the liquid. How do they compare? Why?

2. Calculate the average density of your three trials. Show your calculation,

3. The unknown liquid was glycerol with a density of 1.25 g/mL. Which of your trials was closest to that value?

4. Consider your average. What is your percent error? (The formula is in the introduction. Show your calculations). Are you analyzing accuracy or precision?