Lab 1: Density and Measurement Precision

Procedure	Observations
1. Obtain a clean, dry 100 mL graduated cylinder. What is the volume difference between adjacent marks?	Volume difference b/t adjacent marks, 100 mL grad cylinder: _____mL
2. The precision of volume measurements is the difference between adjacent marks divided by 5 (since you can estimate this). Record this precision, and remember to always read volumes from this cylinder to this precision.	Precision of volume readings, 100 mL grad cylinder: +/- ___mL
3. Weigh the empty cylinder on the balance to the nearest 0.01 g.	_____ g
4. Remove and replace the empty cylinder on the balance a few times. Does the scale give the same reading each time? Record these readings to get an idea of the precision of the balance measurements.	+/- _____ g.
5. Fill the cylinder to 100 mL with room temperature water. Dry the outside if necessary. Record the fill volume to the precision you determined in step 2 – it may be slightly below 100 mL! (Measurements above 100 mL are invalid → remove liquid.)	Fill volume: _____ mL
6. Weigh the filled cylinder. Repeat step 5 and 6 twice (but not step 3 – it won't be dry).	Masses of filled cylinder:
7. Compute the mass of water from the difference of the filled and empty cylinder.	Mass differences:
8. Compute the density of water in g/mL from its mass and volume, and	Densities:

determine average and standard deviation for your density data. Check sig figs. Show a sample calculation (or take a picture of it).	Sample calc:
9. Compare densities within your group, and with expectations. (Hint: you'll need to estimate the water temperatures.)	Group data: Expectations (and source): Comments:

Part 2: Make and determine the mass and density of a stock solution (3.0 M NaCl)

Procedure	Observations
1. Plan how to make 100 mL of a 3.0 M NaCl solution, using table salt. Summarize your calculations at right (or take a photo).	I need _____ g of NaCl to make the solution.
2. Now make the solution, recording the mass of table salt that you actually weighed out. It must be different than the target mass.	
3. Devise, describe, and execute a way to fully mix the solution.	
4. Calculate the concentration of your stock solution, using *real volume and mass readings*. It should be close to 3.0 M, but not exactly 3.000 M. Show your calculation or take photo of it.	Actual concentration of stock NaCl solution: ____M
5. Grab a clean, dry 25 mL grad cylinder. Weigh it 3 times.	Empty mass, 25 mL cyl:
6. With what precision can you read its volume?	Precision of 25 mL cyl: +/- _____mL
7. Rinse the cylinder with a couple ml of your "3.0 M" NaCl stock solution	
8. Use the 25 mL cylinder to determine the density of your 3.0 M NaCl stock solution, using real mass and volume readings. Calculate average and standard deviation for your density measurements.	Mass filled = _____ g At volume = _____ mL Mass difference: _____ g Density = _____ g/mL
9. Compare densities within your group.	Group data:

	Comments:

Part 3: Make three dilutions of the 3M NaCl solution and determine the density of these standard solutions.

1. Use the Dilution Equation (M1V1 = …) to compute target volumes of the stock 3.0 M salt solution needed to prepare 25.00 ml each of the following concentration solutions:

2 M

1 M

0.5 M

Note: The actual concentrations of the standard solutions will be based on real volume observations recorded below. A data table has been set up for you.

Target volumes of 3.0 M NaCl solution needed:

2 M: need _____ mL 3 M stock solution to make 25 mL 2M solution.

1 M:

0.5 M:

Sample calculation:

2. Average mass of clean, dry 25 mL cylinder (copied from Part 2).

	"2 M"	"1 M"	"0.5 M"
Initial mass of 25.00 mL cylinder	_____ g		

3. Make the three dilutions by following the proper dilution technique:

a) Measure out the initial volume of 3 M NaCl needed in each case, using the smallest possible cylinder. Read and record volume.

b) Transfer to a 25 mL cylinder, with rinsing.

c) Add water to ~ 24 mL mark and mix well.

d) Add water to reach 25 mL mark. Read and record volume.

What glassware was used to make the dilution?_____

	"2 M"	"1 M"	"0.5 M"
Actual volume of 3.0 M NaCl added (should not be identical to targets!)	_____ mL measured in ?__ mL cyl.		
Final volume of solution			
Calculated concentration of each solution (with proper sig figs.)			

Sample calculation of actual concentration:

4. Dry the outside of the cylinder, if necessary, and weigh the filled cylinder on the balance. Determine the mass of the solution in the cylinder.

	"2 M"	"1 M"	"0.5 M"
Final mass of filled grad. cylinder			
Total mass of the solution in the cylinder			

	Density of the solution			
5. Show a sample density calculation.	Sample calculation:			

Part 4: Determine the density and concentration of an unknown NaCl(aq) solution. (Data collected by Dr. D, 13 Aug 2020)

1. Obtain a sample of sodium chloride solution of unknown concentration from the instructor	Unknown #: 2 and 5
2. Determine the mass of a clean, dry 25 mL cyl:	Mass of empty 25 mL cyl: 12.12 g
3. Determine the mass of the cylinder filled to 25.00 mL with each unknown solution:	Unknown 2: 39.00 g in 25 mL cyl. Unknown 5: 38.15 g in same 25 mL cyl.
4. Working with your group, use your combined density measurements of five solutions (water and 4 different NaCl solutions) to determine the concentration of unknowns #2 and #5 based on Dr. D's data. Be sure to show a sample calculation of the final step.	Mass of solution: Density: Concentration: Sample calc: Actual values: contact Dr. D

When finished, upload any sample calc photos into a single Word document. Add captions identifying each photo, then upload the Word document below.