Experiment 1: Use of Common Lab Equipment, and Determining Significant Figures in Equipment[[1]](#footnote-1)

PLEASE READ THE PROCEDURE HANDOUT BEFORE YOU START THE LAB.

Fill in your answers as they correspond to the instructions for this lab. In SECTION 1, fill in the data tables collected during lab. In SECTION 2, copy your data and perform your calculations. In SECTION 3, copy your results from the calculations section. In SECTION 4, Answer all the post-lab questions.

**SECTION 1: DATA TABLES**

PART IA: CENTIGRAM BALANCE

|  |  |  |
| --- | --- | --- |
| 1. Precision of Balance | (**Number of places after decimal point)** | |
|  | Direct (using tare) | Indirect (by difference) |
| (3&4) Mass of Metal Slug (direct method) |  | ——NA—— |
| (5&6) Mass of Beaker or Paper | ——NA—— |  |
| (5&6) Mass of Beaker or Paper + Metal Slug | ——NA—— |  |

PART IB: ANALYTICAL BALANCE

|  |  |  |
| --- | --- | --- |
| 1. Precision of Balance   (Number of places after decimal point) |  | |
|  | Direct (using tare) | Indirect (by difference) |
| (2) Mass of Metal Slug (direct method) |  | ——NA—— |
| (3) Mass of Beaker or Paper | ——NA—— |  |
| (3) Mass of Beaker or Paper + Metal Slug | ——NA—— |  |

PART IC: MASS OF CHEMICALS (DIRECT METHOD)

|  |  |
| --- | --- |
| (4) Mass of Salt |  |

PART IIA: MENISCUS READER

No data table necessary for Part IIA.

PART IIb: WATER TEMPERATURE & DENSITY

|  |  |
| --- | --- |
| (1) Temperature of Water | **PUT ANSWER HERE** |
| (2) Density of Water at the measured Temperature (2) from the CRC | **PUT ANSWER HERE** |

PART IIB: VOLUME MEASUREMENTS; 25 mL GRAD. CYLINDER

|  |  |
| --- | --- |
| (3&4) Precision on Graduated Cylinder | (**Number of places after decimal point)** |
| (5) Mass of Empty Graduated Cylinder | **PUT ANSWER HERE** |
| (7) **Volume of Sample 1 (eye-level reading)** (V1) | **PUT ANSWER HERE** |
| (8) Volume of Sample 1 (eye above meniscus) (Vabove). | **PUT ANSWER HERE** |
| (8) Volume of Sample 1 (eye below meniscus) (Vbelow). | **PUT ANSWER HERE** |
| (9) Mass of Cylinder + Sample 1 (M\*1) | **PUT ANSWER HERE** |
| (11) Volume in Cylinder After Adding Sample 2 (V1+2) | **PUT ANSWER HERE** |
| (12) Mass of Water + Cylinder After Adding Sample 1 & 2 (M\*1+2) | **PUT ANSWER HERE** |

PART III: VOLUME MEASUREMENTS; BURETTE

|  |  |  |  |
| --- | --- | --- | --- |
| (1) Precision on Burette  (Number of places after decimal point) | **PUT ANSWER HERE** | | |
| (2) Initial Volume on Burette (Vi) |  |  |  |
| (6) Ending volume on the Burette (Vf) |  |  |  |

### Part IV: Temperature Calibration and Thermometer use-thermometer check

### Part IVa: Temperature Calibration and Thermometer Use-Calibration at the boiling point of water

|  |  |  |  |
| --- | --- | --- | --- |
| (4) Precision on thermometer | (**Number of places after decimal point)** | | |
| (3) Note the temperature range of the thermometer |  | | |
| (6) Experimental Temperature of the freezing point |  |  |  |
| (6a) Expected freezing point at normal atmospheric pressure (101kPa) | (see chart in CRC) | | |
| (7) Experimental Temperature of the boiling point |  |  |  |
| (7a) Expected boiling point at normal atmospheric pressure (101kPa) (see chart in CRC) | (see chart in CRC) | | |
| (8) Actual atmospheric pressure |  | | |

**SECTION 2: CALCULATIONS**

Refer to the handout ‘Exp. 1 Calculations’ for instructions. Use the data from your data tables in section 1 to perform your calculations in this section. **Show your calculations using correct significant figures and units.**

PART IA: CENTIGRAM BALANCE

|  |  |
| --- | --- |
| Show your work | Indirect (by difference) |
| (Ia step 4) Copy **Mass of Slug and Beaker or Paper** |  |
| (1a step 4) Copy **Mass of Beaker or Paper** |  |
| Calculate **Mass of Slug by Difference** |  |

PART IB: ANALYTICAL BALANCE

|  |  |
| --- | --- |
| Show your work | Indirect (by difference) |
| (Ib step 3) Copy **Mass of Slug and Beaker or Paper** |  |
| (Ib step 3) Copy **Mass of Beaker or Paper** |  |
| Calculate **Mass of Slug by Difference** |  |

PART IC: MASS OF CHEMICALS (DIRECT METHOD)

No calculations in Part IC.

**Use the eye-level readings for all calculations. Show your work for all calculations on this report sheet. You can show your calculations on a separate sheet of binder paper, but the work must be neatly documented so that I can follow the work.**

| PART IIB: VOLUME MEASUREMENTS & MASS MEASUREMENTS IN GRAD. CYLINDER- | |
| --- | --- |
| (IIB Procedure step 11) Volume in Cylinder After Adding Sample 2 | V2=(V1+2)— (V1) |
| Volume of Sample 1+ 2 (From data table) | **Show work here** |
| (IIB Procedure step 7) Volume of Sample 1 |  |
| **CALCULATE THE MASS OF THE VOLUMES BY SUBTRACTION** | |
| M cylinder +sample 1 — M empty cylinder= M1 | **Show work here** |
| M cylinder +sample 1+2 — M cylinder +sample 1 = M2 | **Show work here** |
| Calculate the density of sample 1 using the mass of sample 1 and the volume of sample 1 | d1= M1/ V1  **Show work here** |
| Calculate the density of sample 2 using the mass of sample 2 and the volume of sample 2 | d2= M2/ V2 **Show work here** |
| Calculate the difference between the densities. This is the range of your data. | (d2— d1) = ∆dUse the absolute value for your answer. **Show work here** |
| Calculate the **Average density for your data** | Average density = (d1+ d2)/2 **Show work here** |
| Calculate the **percent difference-**This value represents the precision of the measurements. | **Show work here** |
| Calculate the **percent error-**This value represents the accuracy of the measurements | **Show work here** |

|  |  |  |  |
| --- | --- | --- | --- |
| PART III: VOLUME MEASUREMENTS; BURETTE | | | |
| Volume of the sample you delivered by subtraction Vf– Vi **Show work here** |  |  |  |

|  |  |  |
| --- | --- | --- |
| Part IVA: Temperature Calibration and Thermometer use-thermometer checkPart IVB: Temperature Calibration and Thermometer Use-Calibration at the boiling point of water | | |
|  | IVA Freezing point | IVB Boiling point |
| Calculate the difference between the temperatures. This is the range of your data. (T3— T1) = ∆TUse the absolute value for your answer. | **Show work here** | **Show work here** |
| Calculate the **Average temperatures for your data** Average T = (T1+ T2 +T3)/3 | **Show work here** | **Show work here** |
| Calculate the **percent difference-**This value represents the precision of the measurements. | **Show work here** | **Show work here** |
| Calculate the **percent error-**This value represents the accuracy of the measurements | N/A | **Show work here** |

**SECTION 3: RESULTS TABLES**

This section is to organize and consolidate the results of the experiment. Copy your results from the data tables and calculations section.

PART IA: MASS MEASUREMENT - CENTIGRAM BALANCE

|  |  |
| --- | --- |
| Mass of Slug by Direct Method |  |
| Mass of Slug by Difference |  |

PART IB: MASS MEASUREMENT - ANALYTICAL BALANCE

|  |  |
| --- | --- |
| Mass of Slug by Direct Method |  |
| Mass of Slug by Difference |  |

PART IC: MASS MEASUREMENTS USING CHEMICALS

|  |  |
| --- | --- |
| Mass of NaCl on Centigram Balance |  |

PART IIB: VOLUME MEASUREMENTS - GRAD. CYLINDER

|  |  |
| --- | --- |
| Average % Difference= |  |

PART IIC: VOLUME MEASUREMENTS – BURETTE

See questions to discuss your observations of the data.

PART III: COST OF LAB DRAWER

|  |  |
| --- | --- |
| The Sum of the Costs of the Glassware and Instruments in Your Lab Drawer |  |

**SECTION 4: QUESTIONS**

Answer the following questions with complete sentences and good grammar on this report sheet. Alternatively, you can type your answers if you so desire.

1. What is a meniscus?
2. Where is a liquid volume reading taken in relation to a meniscus?

1. In Part IIB, you determined the volume of water based on reading the volume in a graduated cylinder and the mass of the volumes water in the cylinder. Answer the following questions:
   1. Determine the volume of the water in the cylinder based on the mass of the water in the cylinder: Use the mass of the water in the cylinder and the density of the water from the CRC (IIb 1 & 2)
   2. Were the volumes the same? If they differed, how much did they differ by? For example, your volume by reading might be 10.3 mL and your volume by mass might be 10.8 mL.
   3. What does the percent difference tell you in terms of your precision using the graduated cylinder?
   4. Why was it important to take the temperature of the water?
2. Which of the following pieces of equipment is designed to deliver a volume of liquid? Which is designed to contain a specific volume of liquid? Explain your choices denoting the differences between the types of glass ware.
3. graduated cylinder,
4. pipette,
5. burette.

1. Suppose a 10-mL burette is used that has calibration marks representing each 1-mL and 0.1-mL. Accurate readings should be estimated and recorded to the nearest (a) 1.0-mL, (b) 0.1-mL, (c)0.01-mL, (d) 0.001-mL. Choose one and explain your answer.

1. An experiment calls for the measurement of 50-mL of water. Three students working in a group discuss the appropriate graduated cylinder to use to obtain the 50-mL water. Student A wants to use a 10-mL graduated cylinder with a precision of ±0.01mL but they would have to make 5 (five consecutive measurements to obtain the total volume); Student B wants to use a 25-mL with a precision of ±0.1 mL but they would have to make 2 (two consecutive measurements to obtain the total volume); Student C wants to use use a 100-mL with a precision of ±0.2 mL with no extra measurements.
2. Which student’s choice would allow the group to have the smallest overall systematic error?
3. Why is it important to choose the tool with the appropriate precision to make a measurement?
4. Although we did not use linear measurement in this lab, we often should consider significant figures in other tools. Consider a block with rectangular sides whose dimensions have been measured with a millimeter ruler. The height is 254.7 mm, the width is 136.8 mm, and the depth: 25.3 mm.
   1. Determine the volume of the block in cubic millimeters. Carry the answer to 5 significant figures

* 1. Determine the volume of the block if you assume that each of the above measurements should be 0.1 mm higher than listed. Carry the answer to 5 significant figures
  2. With which digit do the answers in parts ‘a’ and ‘b’ begin to differ? If you report the volume using all of the digits that are the same in parts ‘a’ and ‘b’ plus one more digit where the two values do not agree, how many digits should you report?
  3. How many digits would you report according to the rules for significant figures? Is this the same as in part c?

1. The density of water is very close to 1 g/mL at room temperature. You wish to determine the density of a sample with an approximate volume of 25 mL, and an approximate mass of 25 g. To how many significant figures should you report the density if you use the following tools: (Precisions for the tools are listed in Tables 1 & 2 in the instructions.) Please **explain** your choice in a complete sentence. Example: A kitchen balance with a precision of ±0.2g and a 25-mL graduated pipette. **For example, the mass of a sample of water is 25.0 g using a kitchen balance. The volume of the sample is 25.00 mL using a 25-mL graduated pipette. Since the mass of water has 3 significant figures and the volume of water has 4 significant figures, one would report 3 significant figures. The density would be 1.00 g/mL. GIANT HINT: Read the background document when doing this problem!**
   1. Analytical balance and 25-mL pipette
   2. Centigram balance and 25-mL pipette
   3. Semi-micro balance and 50-mL burette
   4. Centigram balance and 100 mL graduated cylinder
2. A student fills a burette with distilled water, adjusts the meniscus to reread 0.00-mL, and allows water to drain out until a reading of 10.00-mL is obtained. The water sample, weighed by difference has a mass of 9.72 g indicating that 9.72 mL of water were probably delivered. Which of the following experimental errors will account for the large difference between the volume according to readings and the volume according to mass? (There might be more than one correct or wrong answer). Give an explanation why each choice is either a contributing factor to the error in the volume or not a contributing factor to the error in the volume. (it helps to draw pictures!)

a) Initially the meniscus was above the 0.00-mL mark.

b) The final meniscus was below the 10.00-mL mark.

c)Air was not cleared from the burette tip before delivering the sample.

d)Water leaked from the burette into the beaker after the final burette reading was taken.

1. This experiment and report sheet could not have been done without the generous support of former students. I would like to especially thank Isabella Germek for her tireless efforts to improve this experiment and especially the report sheet. It is still evolving, Audra Tendzeldam for reviewing the current procedure, and Dr. A. Reyes for his constant support and guidance in the matters of error analysis. [↑](#footnote-ref-1)