COMMUNITY COLLEGE OF PHILADELPHIA

PHILADELPHIA, PENNSYSLVANIA

Experiment Number: M-1

Title: Measurement of Length and Mass

Performed by: George Gamma

Partners: Albert Alpha

Robert Beta

Physics Course: Physics 140

Lab Section No: 005

Lab Day/Hour: Wednesday 12:40

Lab Instructor: Mr. Das

Date Performed: 9/9/15

Date Due: 9/16/15

Purpose

The purpose of this experiment is to become familiar with several laboratory measuring devices, to study some of the methods by which laboratory measurements are made, and to study methods for determining the density and specific gravity of a body.

(*Note: Use your own words.*)

Procedure

Calipers were used to find the dimensions of two different cylinders. The cylinders were weighed and their densities calculated as mass per unit volume. These experimental values were compared with accepted densities of the substances from which the cylinders are made. The densities were then redetermined using Archimedes' method, where the buoyant force of water on each cylinder determines its volume. These results were then compared with the previously determined densities in an attempt to show consistency of these measured values.

(*Note: The above is a sample paragraph only. Use your own words when writing the procedure. However, the following sentence may be copied directly.*)

The detailed procedure that was followed can be found in *Physics Laboratory Instructions*, Volume I, Community College of Philadelphia, John Wiley & Sons, 2005.

(*Note: Any deviations to the procedure should be explained here. Explain what the deviations were and why you made them. Alternatively, you may briefly describe or summarize each of the steps you took. These may be summaries of the steps described in the laboratory manual, but do not copy them from the lab manual. Again, any deviations from the procedure given in the lab manual should be explained. Use your own words.*)

(*Note that the above two sections must be typed.*)

Part I: Vernier Calipers

Zero Reading:_____0.01_____ cm
Least count: _____ cm

Sample Material	Reading	1	2	3	Average
		cm	cm	cm	cm
Steel	Diameter	1.06	1.04	1.05	
	Diameter, Corrected	1.05	1.03	1.04	1.04
	Length				
	Length, Corrected				5.03
	Diameter				
	Diameter, Corrected				
	Length				
	Length, Corrected				

Part II: Micrometer Calipers

Zero Reading:_____–0.0015_____ cm
Least Count: _____ cm

Sample Material	Reading:	1	2	3	Average
		cm	cm	cm	cm
Steel	Diameter	1.0387	1.0377	1.0374	
	Diameter, Corrected	1.0402	1.0392	1.0389	1.0394
	Diameter				
	Diameter, Corrected				

Part III: Density as Calculated from Mass and Volume

Sample Material	Mass	Volume	Density, Calculated	Density, Accepted	Percent Error
	g	cm^3	g/cm^3	g/cm^3	%
Steel	*34.0*	*4.27*	*7.96*	*7.90*	*0.759*

Part IV: Specific Gravity by Archimedes' Method

Sample Material	Weight in Air	Apparent Weight in Water	Specific Gravity Calculated	Specific Gravity from Part III	Percent Difference
	gwt	gwt			%
Steel	*34.0*	*29.8*	*8.10*	*7.96*	*1.74*

(*Note: Unless you are directed otherwise, the above data tables should be completely filled in. Print data neatly in ink. If you make a mistake draw a SINGLE LINE through the error and print the correct value above it.*)

Graphs and Diagrams

(*If any. There are no graphs and diagrams associated with experiment M-1, so this section would be left out.*)

Calculations

Part III.

Volume of the steel cylinder.

$D = 1.0394 \text{ cm};\ L = 5.03 \text{ cm} \quad V = \dfrac{\pi D^2}{4} L$

$V = \dfrac{(3.14159)(1.0394)^2}{4}(5.03) \text{ cm}^3;\ \boxed{V = 4.27 \text{ cm}^3}$

Error analysis for the volume of the steel cylinder.

Note that for a simple error estimate we use the least count of each measuring instrument.

$D = (1.0394 \pm 0.001) \text{ cm};\ L = (5.03 \pm 0.005) \text{ cm}$

$e_D = \dfrac{\Delta D}{D} = \dfrac{0.001}{1.0394};\ e_D = 0.001; \quad e_L = \dfrac{\Delta L}{L} = \dfrac{0.005}{5.03};\ e_L = 0.001$

Error in volume

$e_V = 2e_D + e_L;\ e_V = 0.002 + 0.001;\ e_V = 0.003$

$V = 4.27(1 \pm 0.003) \text{ cm}^3$ or $V = (4.27 \pm .01) \text{ cm}^3$

or $V = 4.27 \text{ cm}^3 \pm 0.3\%$

Density of the steel cylinder.

$\rho = \dfrac{m}{V};\ \rho = \dfrac{34.0 \text{ g}}{4.27 \text{ cm}^3};\ \boxed{\rho = 7.96 \ \dfrac{\text{g}}{\text{cm}^3}}$

Percent error with the accepted value of the density of steel.

$$\%\text{ error in density of steel} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100\%$$

$$= \frac{7.96 - 7.90}{7.90} \times 100\%$$

$\%$ error in density of steel $= 0.759\%$

Error analysis for the calculated density of steel.

$m = 34.0 \pm 0.1 \text{ g}$

$e_m = \dfrac{\Delta m}{m} = \dfrac{0.1}{34.0};\ e_m = 0.003$

$e_\rho = e_m + e_V;\ e_\rho = 0.003 + 0.003;\ e_\rho = 0.006$

$\rho = 7.96(1 \pm 0.006) \dfrac{\text{g}}{\text{cm}^3}$ or $\rho = 7.96 \pm 0.05 \ \dfrac{\text{g}}{\text{cm}^3}$

or $\rho = 7.96 \dfrac{\text{g}}{\text{cm}^3} \pm 0.6\%$

*Note that for this example the **actual** percent error in the density of steel is greater than the **estimated** error in the density of steel.*

Be sure to explain any discrepancy like this in your Analysis and Discussion section. What errors did you not take into account that could explain this difference?

Calculations

Remarks.

Calculations may be printed neatly by hand. State which part of the experiment the calculation relates to and what you are calculating. Numbers must agree with what you have recorded on your data sheet. Answers should have the proper number of significant figures and include units. If you wish to type this section you must use an equation editor to enter formulas. Your instructor can show you how to do this.

The calculations on the previous page are samples only. Numerical data may be different for the actual experiment and there may be additional sample calculations you need to include.

It is only necessary to have ONE sample calculation of each type that you do.

Answers to Questions

1. Compare the readings taken with the vernier calipers to those taken with the micrometer caliper. Are there deviations? Discuss reasons.

   Type your answer here.

2. What is the least count of each type of caliper?

   Type your answer here.

3. Why is the concept of "significant figures" important?

   Type your answer here.

(*Note: This section must be typed. Formulas, diagrams and special must also be typed. See your instructor or the Instructional Aide if you need help*.)

Analysis and Discussion

All paragraphs must be typed and double spaced. **(**Special symbols and formulas must also be typed.) Discuss the accuracy of results obtained. Identify several possible sources of error. Discuss the experimental results in relation to accepted principles; were these theories verified by the experiment?

Besides the sources of error give a general discussion of the experiment. Was the purpose of the experiment achieved? Discuss parts of the experiment (if any) that were problematic or that you had difficulty with. Do you have any suggestions to improve the experiment, such as a modified procedure or different equipment? Also describe parts of the experiment (if any) that you liked or that you thought went better than you expected.

You may share advice with your classmates but the lab report you turn in must be your own work. Do not copy from someone else or let someone else copy from you.

"Neither a borrower nor a lender be." – From Shakespeare's *Hamlet*