

## Experiment 1 Guide

After you performed your first physics experiment in lab, it is time to write a lab report about your findings! Your report should be written in such a way that a reader who is not very familiar with the experiment or the background theory should be able to understand all the concepts and should be able to follow your steps to repeat the experiment. It should also be very concise and to the point. Please check out the sample lab report and follow all the guidelines posted on our IPL lab report help page: <https://web.northeastern.edu/ipl/lab-reports/>

Below is a bulleted list of all the important points that should be mentioned in your first lab report. Make sure to cover all these points and to answer all the questions posed in the procedure part of your lab manual. Keep in mind that your report should not be a bulleted list of answers to those points. It should be written in an essay form with logically connected sentences and paragraphs, and the writing should flow smoothly.

### **Abstract: (1 short paragraph. Optional for 1 bonus point)**

The abstract should contain a very brief description of your experiment (density of cylinders & background radiation count rate) and the summary of your results (final average value of density and the average background count rate with their respective errors).

### **Introduction: (up to 1 page)**

- Cover at least two of these three topics below in your theory section:
  - 1) Define different types of errors (i.e., instrumental, systematic, and random), and explain the differences between them.
  - 2) Explain how you would compute instrumental and random errors.
  - 3) Define the standard deviation, and the standard error in the mean.
- Write down the definition of density. Explain how you can measure it.
- Explain what background radiation count rate is, and how to measure it.
- Summarize your goals and what you did in investigations 1&2.

### **Investigation 1: Density of a Material**

- Describe the setup of Investigation 1 (i.e. the equipment used).
- Describe the procedure of Investigation 1 (i.e. what you did).
- For directly measured quantities, explain where the errors come from and how they are determined.
- Insert the data table you prepared in lab. Make sure you have the correct units and proper number of significant figures. Do not use a screenshot but copy the actual table from Excel into your Word document.
- Explain how you calculated the volumes of the cylinders and how you propagated the errors.
- Explain the water immersion method, mention your results and compare them with the volume computed from the dimensions of the cylinder. Mention which method is more precise.
- Explain how you calculated the densities of the cylinders and how you propagated the errors.
- Explain how you calculated the average density and its error.
- Include the plot of mass vs. volume with proper labels, units, error bars, and a trendline. Again, do not use a screenshot but copy the actual plot from Excel into your Word document.
- Explain how the slope of this plot is related to density. Include the slope and the error in the slope value you found by using the IPL Straight Line Fit calculator.
- Compare the density obtained from the plot to the average density obtained previously.

### **Investigation 2: Measurement of the Radiation Background Statistical Variation**

- Describe the setup of Investigation 2 (i.e. the equipment used).
- Describe the procedure of Investigation 2 (i.e. what you did).

- Insert your data table. Make sure to have the correct units and proper number of significant figures.
- Mention the average count rate.
- Insert the histogram of background counts. Your histogram should show the position of average count and the FWHM with arrows.
- Explain what FWHM is and how it is determined, and write down the estimated uncertainty of the average count, computed using FWHM.
- Compare your results with another group. Give a reasonable explanation if they don't agree.
- Mention the standard deviation of your data and make an order of magnitude comparison to the value obtained from FWHM.
- Compute the standard error in the mean.

**Conclusion: (up to ½ page)**

- Briefly describe what you did in investigation 1 and describe your quantitative results. Mention the unaccounted-for errors. Propose an improvement to investigation 1 to get better results (more accurate and precise).
- Repeat the same thing for investigation 2.

**Questions:**

Question 1-5 are required. Include your answers to Honors questions 3&4 for bonus points.