Purpose and Format of Junior Lab Preliminary Experiments

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(Dated: August 15, 2014)

1. INTRODUCTION

Welcome to Junior Lab. Students who have not acquired basic experimental skills before going into the complex experiments of Junior Lab are at some disadvantage. Therefore, the first few weeks of 8.13 are devoted to a variety of preliminary experiments and exercises which will familiarize you with the concepts, apparatus, and procedures you will use in the longer experiments that follow. Students with extensive laboratory experience may demonstrate their prowess by exceptionally skilled execution of these simple experiments and exercises.

The three preliminary experiments are concerned with optical interferometry, the photoelectric effect, and Poisson statistics, emphasizing the wave, particle, and statistical natures of light, respectively. Each requires adjusting equipment, making measurements, analyzing data, estimating physical quantities, assessing random and systematic errors, and keeping careful records in your notebook of all the above activities. Each experiment is designed to require only three hours in lab and about 6 hours of homework to obtain presentable results, although you will be allowed 4.5 hours of lab time.

2. THINGS TO DO BEFORE COMING TO LAB

There are no regular lectures in Junior Lab. Only cursory explanations of the relevant theory are generally presented in the lab guides. Therefore, you will find it essential for a proper understanding of the experiments to dig the theoretical background out of the recommended course text (Melissinos), your other textbooks, or the references available from the Junior Lab electronic library, the Physics Reading Room, and the Science Library. Before starting a new experiment, you should read the guide, consult the references, and write out the answers to the preparatory problems, which are to be handed in before you start the experiment. Considering the limited time available for your work in the laboratory, it is advisable to plan your work ahead of time. In your notebook:

1. list the objective(s);
2. make a list of the tasks you have to perform and the data you must obtain;
3. identify the required calibrations;
4. attempt to foresee how particular problems can be circumvented.

3. EXAMPLE: PHOTOELECTRIC EFFECT

Objectives: Measure the relationship between photon energy, retarding voltage (between anode ring and cathode), and photoelectron current using a mercury discharge lamp and thin film interference filters (for selecting specific mercury emission wavelengths and an integral photocell).

Procedures:

1. Capture and focus the light from the mercury lamp inside of the anode ring.
2. Ground the apparatus to make it insensitive to interfering signals and currents.
3. Explore the effects of stray light entering the apparatus on the measured photocurrents.
4. Measure the photocurrent as a function of retarding voltage for several different wavelengths and repeating several times to build up meaningful statistics.

Calibrations: Calibrate the electrometer and voltmeter against the best available meters.

Possible problems: Changing lamp intensities, ground loops, electromagnetically induced noise, stray light from the room, poor alignment of photocell in the light beam.

4. DOCUMENTATION: THE NOTEBOOK

For all experiments, you must record in your lab notebook sufficient information about what you have done so that you could write a complete and publishable account of your experiments days or years later without having to do anything over again. That means your lab notebook must have dates, diagrams, narratives, tables of raw data, formulas, computations, reduced data, error analysis and conclusions in a neat, compact, and orderly arrangement. Your Junior Lab notebook should have a respectable place on the shelf next to your later research notebooks.

8.13-14 Experimental Physics I & II "Junior Lab"

Fall 2016 - Spring 2017