

Determining Resistance vs Temperature in Magnetic Samples Final UROP Summary

Firstly, it should be noted that due to complications with my original proposal I was unable to work on that project. The initially proposed project was Determining the Nature of the Formation of Magnetic Poles, but because of an unavailability of samples that was unable to be pursued. As such, my mentor instead provided me with a new project to work on, in which I was measuring the resistance change as a function of temperature in specific magnetic samples, which were alloys of iron, nickel, and cobalt. Ultimately, this project was plagued with complications as well, primarily because of equipment malfunction in the lab, and I was unable to completely finish it by the project deadline. However, the work I did will be utilized by another student at Harvey Mudd University over the summer to finish the project.

As stated before, there were complications throughout the UROP process that prevented completion of the project. However, it was a good learning experience and I managed to accomplish a good deal despite the trouble. Because we were unable to find anyone able to manufacture the samples necessary for the initially proposed project and we lacked the necessary equipment to manufacture them ourselves, my mentor put me on a different project from my original proposal. For this new project I was to be aiding some of my mentor's colleagues, who were investigating the properties of some specific samples made from an alloy of iron, nickel, and cobalt. Identical samples were sent to multiple universities and each was to test a different property; my job was to test how the resistance changed as a function of temperature in the samples.

To this end I used a liquid helium cryostat to cool the sample while measuring the resistance using a four terminal measurement bridge connected to a lock-in amplifier. As the sample cooled I took down the measurement for the voltage, and then using that and a calibration factor determined the resistance of the sample at each temperature. However, I only managed to get a single successful run of data taking before equipment began to malfunction. I was having trouble getting wire bonds to hold at low temperatures at first, and then the bridge began to feed incorrect resistances, as well as malfunctions with the breakout box. Over the time required to fix these I wrote up a Labview program to automate the data-taking process, as well as assisted in the necessary repairs. Once everything was fixed in those pieces of equipment and I started to

take data again, we discovered there were bad solders and broken connections on the cryostat, so those had to be repaired as well, which I again assisted with as best I could. Once those were finally done everything seemed to be running properly, but there wasn't enough time left in the semester for me to take any meaningful data. I got a couple of preliminary runs done, but the process needed to be fine-tuned more and by the time that was finished the semester was over.

I would say that as far as I was able to I accomplished my goals rather well. I stayed active in the lab and accomplished a fair deal despite the setbacks, with the only thing left incomplete being the final data taking. I contributed well to the repairs of the equipment, I learned how to program in Labview and wrote a fully functional program which will be used at Harvey Mudd to take the resistance vs temperature measurements, and I learned a good deal about how working in a lab actually goes. I kept in good contact with my advisor and worked closely with the graduate students in the lab to make sure I was doing everything properly and getting as much as I could out of it, and I feel that it went well overall.

I found the UROP to be very educational and interesting; it allowed me to see what working in a lab is really like and verify that it is in fact what I want to do. I experienced what it's like when things work the way you want them to in the lab and when they don't, and I have a better understanding of the whole process for it. I am disappointed by the setbacks experienced, particularly not being able to complete my alternate project and being unable to even work on my originally proposed project, but I still plan to work on my original project at some point when my mentor manages to get the samples, and my project will soon be finished by another student, so both of those things have at least worked themselves out.