

Please look over the homework and grading policies in the syllabus before you begin.

## 1 Setup

Given an unknown material and some experimental data, your job is to determine three things:

1. The crystal structure, which means lattice vectors, basis, and atomic identity.
2. The electronic gap
3. The speed of sound in the material.

You are given the following information, available at <https://courses.grainger.illinois.edu/phys460/sp2021/project/index.html>:

- The material was synthesized using pure gallium and pure arsenic in a quartz cell.
- An X-ray diffraction pattern. (`diffraction.csv`) This diffraction was performed at a wavelength of 1.6 Å.
- Resistivity vs temperature (`resistivity.csv`)
- Optical absorption (`absorption.csv`)
- An image of the material. (`image.jpg`)
- Heat capacity as a function of temperature (`heat_capacity.csv`)

## 2 Project proposal

For the draft, you will propose a method to determine the three quantities described using the data provided. You should explain the assumptions of that method, and develop a plan to check the assumptions of the method. Your grade will be based on whether, for each quantity, you make a section that does the following, and based on the reasoning in each section.

- Explain a plan to estimate the quantity, using the experimental data. Reference where equations come from, and any manipulations that must be done.
- Explain the assumptions of the plan. If using a model to extract the quantity, explain the assumptions of the model and what evidence you could obtain from the data or by other means to support that these assumptions are accurate.
- Explain what multiple points of comparison you could make to reinforce your conclusions. Can you use several experiments to check the consistency of your conclusions? Is there a range that you expect to obtain *a priori*?
- If there are unit conversions, make sure to write them down explicitly.

**In order to get full credit, you will need to meet with Prof. Wagner for 15 minutes to go over your plan the week after it's been submitted. This will be done the week of 4/19.**

## 3 What you will be doing for the final assignment: execute the plan

This is not due on 4/17; this is a preview for the final project.

In the next few weeks, we will go over some ways of fitting data to help you complete your plan. In the final version of the essay, you will actually estimate the quantities, and quantitatively check how much different experiments agree. You will evaluate the uncertainties and try to estimate how precisely you were able to compute these.