Physics 122
Winter 2012
Lab #7
The Energy Gap in a Semiconductor

Introduction

The energy gap in semiconductors can be determined by measuring the resistance as a function of temperature. In contrast to metals, the resistance of semiconductors decreases as the temperature increases because of the rapid increase in the number of current carriers as the temperature increases. For many such materials, the resistance is described by an exponential:

$$R = \text{(const) } e^{E/2kT}$$

where E is the 'effective' energy gap, T the temperature in Kelvin, and k is Boltzmann's constant.

Procedure:

At your setup find the semiconductor (small wafer with four wires attached). Connect the yellow wires attached to either side of the semiconductor wafer to the ohmmeter, and place the wafer carefully in the test tube. Fill your beaker ½-¾ full with water and ice, and place on the hot plate. Suspend the test tube (using the test tube holder and ring stand) such that it is partially submerged in the ice water but NOT touching any of the sides or bottom of the beaker. Carefully place the thermometer into the test tube with the semiconductor. Wait for the system to equilibrate, measure the temperature, and record the resistance measured by the ohmmeter. Turn on the hot plate, and continue to measure the resistance as a function of temperature from near freezing to near boiling.

Analysis:

Considering the equation above, make a graph which linearizes the data and yields a measure of the Energy gap of the semiconductor.

Questions To Consider for the Discussion of Your Report:

1. What would R vs. T for a metal look like? What would R vs. T for a good insulator look like? How do your results relate to the idea of a semiconductor, which is a good insulator at low Temperatures and a good conductor at moderate temperatures?
2. What would your results look like if you could get the bath down to very low temperatures (such as 100K)? (Consider the idea of a semiconductor).