Prof. Ivan K. Schuller
Physics 211A - Solid State Physics
Fall Quarter 2007

Problem Set 3.

Problem 10.

a) Calculate the Debye-Waller coefficient for a harmonic crystal.

b) Relate this to the mean square atomic displacement.

c) Calculate at what temperature this mean square displacement is 0.2 x lattice spacing.

d) Make a graph of this temperature as a function of the melting temperature for a few (~ 10) elements. What does this suggest?

This is the so-called Lindeman melting criterion.

Problem 11.

a) Using the tight binding method, calculate the band structure $\varepsilon = \varepsilon(\vec{te})$ for a band arising from a single s-level in a face centered cubic crystal.

b) How do the constant energy surfaces appear for $b \langle\langle \pi/a$, where a is the lattice spacing.

Problem 12.

a) Find the temperature depend resistivity of one or more metals of the

Group IA
Group IV A, VA, or VIA
Group VIIIA
Group IB
Group IIIB
high temperature ceramic superconductors.

b) What can you conclude from these temperature dependences in relationship to the scattering mechanisms?

Problem 13.

Design an experiment to measure the temperature dependence (10-300K) of the resistivity of a metal and a semiconductor with an accuracy of 1%.

The type of issues you will have to face are:

a) Which metal and semiconductor?

b) How to attach leads and what is the geometry?

c) What measuring equipment?

d) How to cool down?

e) How to measure the temperature?

This is a practical problem, so “numbers” are essential.

Find some actual data and assure that your estimates are correct and reasonable.