Problem Set 2.

Problem 6.

Explain why it is that x-ray scattering is seldom used for the measurement of phonon spectra. What kind of information related to lattice vibrations can be extracted from x-ray diffraction.

See Ashcroft & Mermin, Chapter 24.

Problem 7.

Consider a linear chain with nearest neighbor interactions in which alternate ions have masses M_1 and M_2.

a) Calculate the dispersion relation for normal modes.

b) Discuss the form of the dispersion relation and the nature of the normal modes for $M_1 >> M_2$.

c) Do the same for $M_1 = M_2$. How can you reconcile this with what we did in class?

Problem 8.

Calculate the density of states for a one dimensional harmonic chain with nearest neighbor interactions.

a) The singularity you find is a van Hove singularity.

b) In three dimensions, the Van Hove singularities are in the derivatives.

Show that if $\omega = \omega(k)$ has a maximum, the derivative of the density of states exhibits a singularity.

Problem 9.

Assume that the total internal energy for a gas of electrons is

$$U = U_o + \frac{\pi^2}{6}(kT)^2 N(\varepsilon_F)$$

Where $N(\varepsilon_F)$ is the density of states for conduction electrons at energy ε_F, ε_F is the maximum energy allowed for electrons.

a) Calculate the specific heat.

b) Assume that the total number of conduction electrons is n.

Discuss why is it that at room temperature one can neglect the contribution of electrons to the specific heat of a solid.