PH207 - Solid State Physics

Problem set N. 6

Handed out 04/05 – Due in 11/05

1. Show that for a system of two independent harmonic oscillators with angular frequencies ω_1 and ω_2 the partition function is the product of the partition functions of the two oscillators and the internal energy is the sum of the internal energies of the two oscillators.
   [*5 marks*]

2. Consider a three dimensional lattice with three identical acoustic modes and three identical optical modes. Assume that they are given by the one dimensional diatomic lattice relations and that the specific heat is the sum of the contribution of the optical branch (described by the Einstein model) and the acoustic branch (described by the Debye model). Knowing that the frequency of the acoustic branch is 10^{12} Hz, the lattice spacing is $2A$ and that the forbidden gap is 3 meV wide (see Problem Sheet n. 5), compute the Einstein and the Debye temperatures of the system.
   [*10 marks*]

3. Compute C_V/NK_B at $T = 0.01\theta$ in the Debye and Einstein model, assuming that θ is the appropriate temperature scale (i.e. respectively the Debye and Einstein temperature).
   [*5 marks*]