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Physics 731 **HOMEWORK ASSIGNMENT #5** **Due: Tuesday, Oct. 10, 2006**
deadline Oct. 12, 2006

Finish reading about phonons: A&M chapters 23, 24, 25. Chap. 24 is rather descriptive and straightforward (except for Fig. 24.6, which we will discuss in class). Chap. 23 will be covered thoroughly in class. After reading pp. 464–465, read pp. 143–145, substituting $\omega_s(k)$ for $\varepsilon_n(k)$, s^{th} branch for n^{th} band, and removing the factor of 2 from spin degeneracy. [Thus, for phonons there is no factor of 2 in eqns. (8.53), (8.54), and (8.58), the $1/4\pi^3$ should be $1/8\pi^3$ in eqns. (8.57), (8.59), (8.60), and (8.63).] In chap. 25 we will only have time to cover lattice thermal conductivity (pp. 495–505) with any care. The rest of that chapter can be skimmed very casually. The objective should be to get a sense of what results are known and what the Grüneisen parameter is; Read problem 25-3 and take note of eqn. (25.46). Finally, review Appendix L and study Appendix M (pp. 784–787). D&G say very little on these topics.

Problems to turn in (read the rest):

1. 23-1 (parts a and c only)
   Hint: Use $\Sigma_s\lambda_s(\mathbf{k}) = \Sigma_\mu D_{\mu\mu}(\mathbf{k})$, and note that the trace is independent of the representation.

2. 23-2

3. 23-3 Hint for part b: assume $\omega(\mathbf{k}) = \omega_0 - \alpha(\mathbf{k} - \mathbf{k}_0)^2$, where $\omega(\mathbf{k}_0) = \omega_0$.

4. 24-3 (parts a and b only; you can simply accept eqn. (N.17) as reasonable or read Appendix N). This problem discusses the Debye-Waller factor, the reduction in beam intensity due to harmonic vibrations, as promised in reply to an earlier question in class. Why is the Debye-Waller factor exp(-2*W*) non-zero for the 2D net of atoms forming the surface of a crystal?

5. 25-3a and 25-5a. (You do not need to do 25-5b, but the solution will also be provided.)