Physics 406

HW #3

(due 02/13/12)

Reading: Omar Ch. 3

Problems:

1. O Ch. 3, Q. 3
2. O Ch. 3, Q. 14
3. O Ch. 3, Pr. 6
4. In the Debye approximation we assume that $\omega = c_s k$. Please consider instead a 3D solid with 1 atom/unit cell and the dispersion relation $\omega = c_s k^2$.

(a) Calculate the density of modes $D(\omega)$.

(b) What is the max frequency ω_{max} (similar to Debye frequency ω_D) that accounts for all the modes in the spectrum?

(c) What is the T-dependence of the specific heat at low T's? ($k_B T \ll \hbar\omega_{max}$)

Hint: leave the answer in terms of the integral

$$I(\alpha) = \int_0^\infty dx \, \frac{x^\alpha e^x}{(e^x - 1)^2} \quad , \alpha > 1.$$

5. What is the specific heat (per unit volume) of vacuum at room T? Assume that the vacuum contains black-body radiation at room T, in thermal equilibrium. Look up the dispersion relation for photons & keep in mind that there is no upper limit on the number of photons.

6. ⊖ Ch. 3, Pr. 4

7. ⊖ Ch. 3, Pr. 5