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Physics 404 **HOMEWORK ASSIGNMENT #11** **Spring 2012**

Due date: Thursday, Nov. 29 **Deadline:** Tuesday, Dec. 4

1. (10) Thermodynamics of a photon gas.

   a) S 7.45, first sentence only. To use the formula, you first need to find U(V,S,N) from eqns. (7.86) and (7.89). For ease of writing, you are welcome to use *a* as given after eqn. (7.88)

   b) S 7.46 a, b, c

2. (5) S 7.54 a Using Stefan's law.

3. (10) S 7.61 Low-temperature heat capacity of liquid ^{4}He. You do not need to repeat the derivation for phonons; just cite the relevant results and where they are modified here.

4. (10) S 7.63 Thermal properties of a 2D material. You do *not* need to do the computer plot of C(T); it looks qualitatively like its 3D counterpart. Just make clear what the low-temperature power-law behavior is and show that at high temperature you retrieve the equipartition result.

Clarification on the density of states (DOS) of a Debye solid:

$\mathcal{G}(\varepsilon) = V/(2\pi)^2\, \varepsilon^2/(\hbar c_s)^3$ for $\varepsilon < \varepsilon_D$ and 0 for $\varepsilon > \varepsilon_D$

The integral of $\mathcal{G}(\varepsilon)$ is N.

To get the energy, etc., one must multiply this by 3, corresponding to the spatial dimension, so the number of oscillators or the number of polarizations. Note that in problem 3, you should not include this factor of 3.