Physics 3180 (Thermal Physics)
spring 2020

Problem Set 9

(due Friday, April 10)

1. **For formal written solution:** Problem 7.44, page 297. Like Problem 7.28 (below), this is a "counting waves in a box" problem, which will give you a chance to review several of the steps in the derivation of the formula for the photon spectrum. As always, please present your solution as a self-contained narrative, broken into paragraphs, incorporating every equation into a complete English sentence.

Additional problems:

2. (a) Compute the quantum volume for an O_2 molecule at room temperature, and argue that oxygen gas under standard conditions can be treated accurately using Boltzmann statistics. (b) At the center of the sun the temperature is approximately 10^7 K and the concentration of electrons is approximately 10^{32} per cubic meter. Would it be accurate to treat this electron gas using Boltzmann statistics? Justify your answer.
3. Problem 7.10, page 265. Remember to distinguish single-particle states from system states. For example, to describe the ground state of the system, you need to specify the single-particle states of all five particles.
4. Problem 7.11, page 269.
5. Problem 7.13, part (b) only, page 269.
6. Each atom in a chunk of aluminum contributes three conduction electrons. Look up the density and atomic mass of aluminum, and calculate the Fermi energy, the Fermi temperature, the degeneracy pressure, and the contribution of the degeneracy pressure to the bulk modulus. Is room temperature sufficiently low to treat these electrons as a degenerate electron gas? Justify your answer.
7. Problem 7.28, part (a) only, page 282. This problem will give you practice working in "n space" and "counting waves in a box." Although we live in a three-dimensional world, many fabricated devices have conducting surfaces that are effectively two-dimensional.
8. Problem 7.51, pages 303–304. In part (f), an approximate graphical estimate is sufficient.