6.728 Applied Quantum and Statistical Physics:

Department of Electrical Engineering and Computer Science
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PROBLEM SET 10

Problem Set Out: 11/27/06   Problem Set Due: 12/8/06 at the beginning of class
Note that the due date is Friday, December 8th.

Problem 10.1 *Entropy and Temperature of a 3D SHO.*
    Problem 25.2 in the text.

Problem 10.2   *Average Thermal Energy in an LC circuit*
    Do problem 26.1 in the text.

Problem 10.3   *Doping in Diamond*
    Do problem 27.3 in the text (assuming the approximations for $N_C(T)$ and $N_V(T)$ given in problem 27.2.

Problem 10.4   *Fermi Dirac Statistics revisited*
    Consider one fermion which has energy level at energy E_l that can be occupied by electrons. Let the electrons have spin, and assume that the only possible states are no particles, one particle of either spin, and two particles of opposite spin.
    Find the average number of particles in this level. How does it compare if the only possible states were no particles or one particle irrespective of spin.

Problem 10.5   *Some Hydrogenic Exercises*

1. Are there continuum (unbound) states for the hydrogen atom? If so, what energy do these states have?

2. How big is the 1s orbital for hydrogenic oxygen with $Z = 8$? (This means there is only one electron.)

3. How many m-values can a 3d orbital have?

4. If an electron is removed for the 1s state of lead, then an electron in the 2p state can radiatively decay to the vacant 1s state. Use a simple hydrogenic model for these two states in lead to estimate the energy difference between these two states. Is the radiation given off in the microwave, optical or x-ray regime?

Problem 10.6   *Particle in a Spherical Box.*
    Find the ground state energy and wave function of a particle in a spherical box of radius R.