

Physics 831 - 2002
Statistical Physics

Problem Set 9

1. A particle with spin $S > 1/2$ and the magnetic moment operator $\hat{\mathbf{M}} = \mu\hat{\mathbf{S}}$ is placed into a uniform magnetic field B . It is weakly coupled to a thermal reservoir at temperature T , with negligibly small coupling energy (respectively, it takes a long time to come to thermal equilibrium). Find the partition function, average energy, and the magnetic moment (6pt)
2. For a quantum harmonic oscillator, with mass m and angular frequency ω , find the probability distribution over the oscillator coordinate q , for given temperature T [you can think of an oscillator weakly coupled to a thermal reservoir, as in the previous problem]. Do the same problem for the classical oscillator. Compare the classical and quantum expressions in the limit of large $kT/\hbar\omega$. (6 pt)
3. Solve the following quantum mechanical problem: find the energy spectrum and the wave functions of a nonrelativistic electron in a magnetic field \mathbf{B} (6 pt)
4. Problem 8.3, p.191 (3 pt)

Problems with numbers are from Kerson Huang, *Statistical Mechanics*, 2nd edition, (Wiley, NY 1987).