Statistical Physics

Problem Set 12

1. Find the T^4 corrections to the chemical potential and internal energy of an ideal Fermi gas of particles with spin $1/2$ for $T \ll T_F$ (6 pt)

2. Consider an n-type semiconductor. There is a conduction band, where electrons have an effective mass m_e. There are also donors, with number density N_D. A common type of donors are impurities which may have one electron on each of them. This electron may go into the conduction band. Assume that the total number of electrons per unit volume, on the donors and in the conduction band, is N_D (ignore the valence band at all, that is assume that the band gap is very large). All electrons on donors have same energy $-E_D$ with respect to the bottom of the conduction band ($E_D > 0$). Find the chemical potential and make a plot of μ vs T, from $E_D/kT \gg 1$ to $E_D/kT \ll 1$. (10)

3. Find the specific heat of an ultra-relativistic electron gas for $T \ll T_F$ (6 pt)

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