PHY 3107, Spring 2017, Homework #7

due Tuesday, March 21

1.) Follow along with the book's example 10.2 for this problem. A) Are Maxwell-Boltzmann statistics valid for oxygen at STP? B) Are Maxwell-Boltzmann statistics valid for conduction electrons in gold at 450 K? [Gold has a density of 19.32 g/cm3, and a molar weight of 197 g/mole. Assume each gold atom has one free conduction electron.]

2.) The Fermi energy is defined at a temperature of 0 K to be $E_F = \frac{h^2}{2m}\left(\frac{3N}{8\pi V}\right)^{2/3}$. For copper, the Fermi energy at 0 K is $E_F = 7.05$ eV. A) Calculate the number of free electrons per unit volume at 0 K. B) Find the number of conduction electrons, or "valence" for copper by dividing the number of free electrons per unit volume by the number of atoms per unit volume (you will need to google the density and atomic weight).

3.) The temperature near the surface of the sun is 5000K. The average energy of a photon is given as $\bar{E}_{photon} = \frac{\int_0^\infty E\, f_{BE}(E) g(E) dE}{N/V} = \frac{\int_0^\infty E\, f_{BE}(E) g(E) dE}{\int_0^\infty f_{BE}(E) g(E) dE} = \frac{\frac{8\pi}{(hc)^3}\int_0^\infty \frac{E^3 dE}{e^{E/k_B T}-1}}{\frac{8\pi}{(hc)^3}\int_0^\infty \frac{E^2 dE}{e^{E/k_B T}-1}}$. Evaluate these integrals to find the average photon energy at a temperature of 5000K.

4.) Given the Fermi energy of an electron in silver at 800K is $E_F = 5.48$ eV, find the energy if the probability of finding the electron in this state is 0.95. [Hint: you will need to use Fermi-Dirac statistics for an electron.]