Physics 831 Quiz #3 - Friday, Sep. 22

your name(s)_____

This quiz is open-note, open-book, open-mouth. Work in groups of 2. Your partner's last name must not be within 6 letters of your last name, this conditions extends cyclically (xyzabc..). Consider a one-dimensional world of MASSLESS electrons (assume two spins) confined to a length L.

1. (10 pts) What is the density of single particle states as a function of the electron energy?
2. (10 pts) If the density (number per length) of the electrons is ρ_0, what is the Fermi energy for a zero temperature gas?
3. If the system is heated to a small temperature T, with the density fixed at ρ_0,
   (a) (5 pts) What is the additional energy carried by the electrons per unit length?
   (b) (5 pts) What is the change of the chemical potential?

(a) $N = 2 \frac{L}{2\pi\hbar} \int_{-p_f}^{p_f} dp_f = \frac{2L}{\pi\hbar} p_f$, $\frac{dN}{dE} = \frac{2L}{\pi\hbar c} = D$

(2 ↑ spins)

(b) $\rho_0 = \frac{2}{\pi\hbar} p_f$, $p_f = \frac{\pi\hbar}{2}\rho_0$, $\varepsilon_F = \frac{\pi\hbar c}{2}\rho_0$

(c) $\frac{1}{L}E^* = \frac{D}{L}\frac{\pi^2}{6}T^2 = \frac{\pi}{3\hbar c}T^2$