In problems 1-3 compare the average number density ρ with the quantum number density

$$\rho_Q = g_s \left[\frac{mc^2 k_B T}{2\pi(\hbar c)^2} \right]^{3/2}$$

. (Note: g_s = 2 for spin-1/2 fermions, = 1 for spin-0 bosons.)

1. Solid copper (M = 64) has a mass density of 8.96 gm/cc. Assuming that each atom in a piece of solid copper provides one electron to the conduction band determine the ratio ρ/ρ_Q at T = 300K. Are the electrons "hot," "cold," or "in between"?

2. A white dwarf is a smallish dense star that you can treat, to first order, as a plasma of protons and electrons. Assuming that the mass density of the star is 10^6 gm/cc at a temperature of 150,000 K, and that there is one electron for every proton, determine the ratio ρ/ρ_Q for the (a) protons and (b) electrons. State for each whether they are "hot," "cold," or "in between."

3. Liquid helium (M = 4) has a mass density of 0.146 gm/cc. Find the temperature at which the ratio $\rho/\rho_Q = 1$ (i.e., "in between").