ASSIGNMENT 5

Due: 27 October 2003

Problems:

1. Show that for a free electron gas the density of states may be written as $D(E) = C_d E^{(d-2)/2}$, where d is the dimensionality of the gas (d = 1, 2, or 3). Calculate C_d for each case.

Note: The initial description of D(E) contained a typographical error.

2. For sodium the valence electrons are well-described as free electrons. Calculate the ratio of the Fermi wave vector to the radius of the largest sphere that can be inscribed within the first Brillouin zone. Hint: You need to consider the 3-dimensional Brillouin zone of the bcc structure.

3. Assuming free electron behavior, what is the separation of energy levels (in eV) at the Fermi level for blocks of Al with volumes (a) 10 cm^3 (b) 10 μm^3 (c) 10 nm^3.

4. Consider free-electron-like sodium metal with a Fermi energy of 3.2 eV, a thermal effective electron mass of 1 and a Debye temperature of 160 K. What fraction of the total heat capacity at 300 K is contributed by the electrons?

5. At room temperature the resistivity ρ of Cu is 1.75 x 10^{-8} ohm-m. What is the mean-free-path of the conduction electrons? The lattice parameter of fcc Cu is 0.361 nm.