PHYS 225 – Spring 2011 **Marie Lopez del Puerto**

HW #23

1. Show that at T = 0K, the average energy of an electron in a metal (in the free electron model) is

$$E_{ave} = \frac{3}{5} E_{F0}$$

2. **(Kasap 4.7 (a) and (b)) Fermi energy of Cu** The Fermi energy of electrons in copper at room temperature is 7.0 eV.

a) What is the speed v_F of conduction electrons with energies around E_F in copper? By how many times is this larger than the average thermal speed $v_{thermal}$ of electrons, if they behaved like an ideal gas? Why is v_F much larger than $v_{thermal}$?

b) What is the De Broglie wavelength of these electrons? Will the electrons get diffracted by the lattice planes in copper, given that interplanar separation in copper is 2.09Å? (*Hint:* remember the Bragg condition $2d\sin\theta = n\lambda$; find the relationship between λ and d that results in $\sin\theta > 1$ and hence no diffraction).

3. **(Kasap 4.8) Free electron model, Fermi energy and density of states** Na and Au both are valency 1 metals; that is, each atom donates one electron to the sea of conduction electrons.

a) Calculate the Fermi energy (in eV) of each at 300K and 0K.

b) Calculate the mean speed of all the conduction electrons and also the speed of electrons at E_F for each metal.

c) Calculate the density of states as states per eV per cm^3 at the Fermi energy and also at the center of the band, to be taken at $(E_F + \Phi)/2$ (see Table 4.1 for Φ).