4/17/01

Lecture 36 Quantum Stat. Mech.

Last time

Fermi momentum $k_F = [3\pi^2\rho]^{1/3}$

Fermi energy $\frac{\hbar^2 k_F^2}{2m} = E_F$

Example prob. 5.13

Copper has a density of 8.96 gm/cm³ and an atomic weight of 63.5 gm/mol.

Assume one valence electron per copper atom.

ρ = # density of Valence electrons $= 6.02 \times 10^{23} \frac{\text{particles}}{\text{mole}} \left[\frac{8.96\ \text{gm/cm}^3}{63.5\ \text{gm/mole}}\right]$

$$\boxed{\rho = 8.50 \times 10^{22}\ e^-/\text{cm}^3}$$

$$k_F = (3\pi^2\rho)^{1/3} = 1.36 \times 10^{+10}\ \text{m}^{-1} = 1.36\ \text{Å}^{-1}$$

$$E_F = \frac{\hbar^2 k_F^2}{2m_e} = \frac{(\hbar c)^2 k_F^2}{2\ m_e c^2}$$

$m_e c^2 = 0.511 \times 10^6$ eV

$\hbar c = 1973.3$ eV-Å

$$E_f = \frac{(1973.3)^2}{2\,(511000)}(1.36)^2 = 7.05\ \text{eV}$$

At what temperature will thermal fluctuations be comparable to the Fermi energy?

$$E_T = k_B T \sim E_F$$

$$k_B = 1.2 \times 10^{-4}\ \text{eV/K}$$

$$T \sim \frac{E_F}{k_B} = 84{,}000\ \text{K}$$

Copper has long since melted.