DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

3.225 Electronic and Mechanical Properties of Materials

Summer Term 2002

Problem Set #2
Due: Day #3

1. An electron is trapped in a one-dimensional energy well of width L with rigid walls. (a) For L = 1 nm, calculate the wavelengths of the three lowest-energy photons capable of exciting electrons from the ground state. (b) At what value of L will the energy gap between the two lowest energy levels equal k_BT at T = 300 K? (c) For L = 1 cm, what would be the quantum number of the energy level k_BT above the ground state at T = 300 K?

2. From the experimental value of the Fermi energy for sodium determined by x-ray emission spectroscopy (2.8 eV), (a) what are the corresponding Fermi velocity and Fermi wave vector? (b) What is the average speed of free electrons in sodium? (c) What are their root-mean-square speed and average kinetic energy?

3. (a) In a three-dimensional free-electron metal at T = 300 K with E_F = 3 eV, what is the ratio of the density of occupied states at 2.9 and 3.1 eV to that at 3 eV? (b) Calculate the same ratio for energies of 2.95 and 3.05 eV.