Physics 201, Fall 2018
Problem Set #10 (due Nov. 30)

Each problem is 10 points.

Problems from Serway, Moses and Moyer:

11.5, 11.9, 11.14, 11.15, 11.18

A1: The microwave spectrum of CO has lines at 0.86mm, 1.29mm and 2.59mm. Compute the photon energies and carefully sketch the energy-level diagram for a CO molecule, assuming that in all transitions the molecule ends up in its ground state. What molecular motion produces these lines?

A2: What is the Fermi speed, that is, the speed of a conduction electron whose energy is equal to the Fermi energy E_F for (a) Na (E_F=3.24eV), (b) Au (E_F=5.53eV) and (c) Sn (E_F=10.2eV).

A3: The energy gap between the valence band (the highest filled band) and the conduction band (the lowest unoccupied band) in silicon is 1.14eV. What is the wavelength of a photon that will excite an electron from the top of the valence band to the bottom of the conduction band? Do the same calculations for diamond, for which the energy gap is 7.0eV.

A4: The energy-band gap in germanium is 0.72eV. What wavelength range of visible light will be transmitted by a germanium crystal? (Think about it carefully!) Now consider a crystal of an insulator whose energy band is 3.6eV. What wavelength range of visible light will this crystal transmit?

A5: A photon of wavelength 3.35μm has just enough energy to raise an electron from the valence band to the conduction band in a lead sulfide crystal. (a) Find the energy gap between these bands in lead sulfide. (b) Find the temperature T for which kT equals this energy gap (at this temperature this material starts conduct electrical current).