PHY 6645 - Quantum Mechanics I - Fall 2011
Homework set # 1, due August 31

1. Assume that the Sun radiates as a black body. You are given the radius of the Sun $R_\odot = 7 \cdot 10^{10}$ cm, the average distance of the Sun to the Earth $d_\odot = 1.5 \cdot 10^{13}$ cm, and the solar constant, the amount of energy falling on Earth when the Sun is overhead, $1.4 \cdot 10^6$ erg/cm$^2\cdot$ sec. Use the information to estimate the surface temperature $T_\odot$ of the Sun. What is the wavelength of a photon of energy $k_B T$?

2. A 100 keV photon collides with an electron at rest. It is scattered through 90°. What is its energy after the collision? What is the kinetic energy of the electron after the collision, and what is the direction of its recoil? What is the wavelength of the initial photon? What is the wavelength of the final photon?

3. If one assumes that in a stationary state of the hydrogen atom the electron is in a circular orbit of length equal to an integral number of the de Broglie wavelengths, one can reproduce the results of the Bohr theory. Work this out.

4. The power radiated by an accelerated charge e is classically given by the formula

$$P = \frac{2}{3}\frac{e^2}{c^3}a^2 \tag{0.1}$$

where a is the acceleration. Calculate the power radiated by an electron in a Bohr orbit characterized by the quantum number n. Let us define the decay rate as the power radiated P divided by the energy emitted in the decay. What is this decay rate when the electron makes a transition from orbit n to orbit $n-1$? Give your result in units of sec^{-1}.

5. Problem 1.4.1 in Shankar's book.