e-mail: wiedemann@tonic.physics.sunysb.edu Tel: 631-632-4489 Fax: 631-632-9718

Problems:

1. An unstable particle having a mass of $m_{\rm parent} = 3.34 \times 10^{-27}$ kg is initially at rest. The particle decays into two fragments that fly off with velocities of 0.987 c and - 0.868 c. Find the rest masses of the fragments. Give your result in a formula before putting in numbers.

2. The average power generated by the Sun has the value 3.74×10^{26} W.
   i) Assuming the average wavelength of the Sun's radiation to be 500 nm, find the number of photons emitted by the Sun in 1 s.
   ii) Assuming the average temperature on the surface of the sun to be 5800 K, find the number of photons emitted by the Sun in 1 s. (Hint: assume that the Sun radiates like a black body, and make use of the formula derived in problem 2 of the last homework.)

3. A light source of wavelength λ illuminates a metal and ejects photoelectrons with a maximum kinetic energy of 1.00 eV. A second light source with half the wavelength of the first ejects photoelectrons with a maximum kinetic energy of 4.00 eV. What is the work function A of the metal? What is the wavelength λ?

4. Johann Jakob Balmer, a Swiss schoolteacher, found by trial and error in 1885 a pocket formula for the wavelengths of spectral lines in hydrogen

   $$\lambda = C_2 \left(\frac{n^2}{n^2 - 2^2} \right) ,$$

   where $C_2 = 3645.6 \times 10^{-8}$ cm.
   i) Show that Balmer's formula is a special case of the Rydberg formula, given in eq. (3.13) of the lecture notes. What is the value of n_f for the Balmer series? Calculate the first three lines in the Balmer series of hydrogen.
   ii) The Lyman series describes the spectral lines of the hydrogen atoms for transitions to the ground state $n_f = 1$. Calculate the first three lines in the Lyman series of hydrogen. Are these lines in the visible, ultraviolet or infrared part of the spectrum?

5. A hydrogen atom initially in its ground state (n=1) absorbs a photon and ends up in the state for which n=3.
   i) What is the energy of the absorbed photon in units of eV?
   ii) If the atom returns to the ground state, what photon energies could the atom emit? (Hint: there is more than one energy!)

6. i) Find the energy of an x-ray photon that can impart a maximum energy of 50 keV to an electron by Compton collision.
   ii) Compton used photons of wavelength 0.0711 nm. What is the energy of these photons? What is the wavelength of the photons scattered at an angle of 180° (backscattering case)? What is the energy of the backscattered photons? What is the recoil energy of the electrons in the backscattering case?