Problem 1 [6 pts]
Lets go back to again look at problem 7 from assignment #3.

Explain, being as quantitative as you can:

(a) Will the distribution predicted in part (c) be in fact the distribution that actually occurs ? Why or why not ?

(b) Given the result from part (b) why aren't the Paschen series lines (those to/from the n=3 state) considered in our treatment of the hydrogen lines we expect to observe ?

(c) In order to calculate N_2/N_{total} needed for estimates of the Balmer series strength, we made the assumption that $N_I = N_1 + N_2$ in order to give us ratios we could easily calculate from the Boltzmann and Saha equations. Justify this assumption.

Problem 2 [6 pts]
Text, Problem 2.7

Problem 3 [3 pts]
Sirius, the brightest appearing star in the night sky, has an apparent bolometric magnitude of; $m_{bol} = -1.55$.
The distance to Sirius is 2.6 pc. Determine the absolute bolometric magnitude of Sirius and compare it with that of the Sun. What is the ratio of Sirius' luminosity to that of the Sun ?

Problem 4 [4 pts]
Assuming that 10 eV could be released by every atom in the Sun through chemical reactions, estimate how long the Sun could shine at its current rate through chemical processes alone. For simplicity assume that the Sun is composed entirely of hydrogen. Is it possible that the Sun's energy is entirely chemical ?

Problem 5 [6 pts]
In class we showed that the classical temperature required for 2 protons to overcome the Coulomb barrier and collide so that the strong nuclear force is experienced is much greater than the temperature in the Sun's central region.

(a) Derive this conclusion (basically go through the derivation in class and substitute in the appropriate values).

(b) One possibility that one might not conclude that this forbids nuclear reactions, is that the velocities used were averages, whereas in fact some particles will have much larger values. If some nuclei have velocities 10 times the root-mean-square (rms) value for the Maxwell-Boltzmann distribution will these nuclei be able to overcome the Coulomb barrier for the temperature of the centre of the Sun (use $T_C = 2 \times 10^7$ K for the Sun) ?
Using the Maxwell-Boltzmann distribution calculate, for T_C of the Sun, the ratio of protons having velocities 10 times the rms value to those moving at the rms velocity.

Problem 6 [5 pts]
Consider thowing 0.5 kg ball's through a doorway (of width 1 m) at 30 km/hour at a wall 5 m from the doorway.

(a) Assuming the wave nature of all particles, what is the de Broglie wavelength of these thrown balls ?

(b) Given that these ball's are acting like waves with a de Broglie wavelength, λ, estimate the distance to the first minimum of the resulting diffraction pattern on the wall. (You might need to review diffraction from any Introductory Physics text and/or go to:
`http://www.walter-fendt.de/ph14e/singleslit.htm`)