Homework Set 24
Due Friday, April 3

1. The *total* angular momentum of an atom actually has three pieces: The orbital angular momentum of the atom, the spin of the electron, and the spin of the nucleus.
   (a) Suppose a hydrogen atom has a single electron in a p-wave (that means $l = 1$). What are the possible values for the total angular momentum of the electron (orbit plus electron spin). The electron has spin ½.
   (b) What are the possible values of the total angular momentum of an entire ordinary hydrogen atom? If there are two ways to make a certain combination, list it twice. Ordinary hydrogen atoms have a nucleus consisting of a proton with spin ½.
   (c) Repeat part (b) for heavy hydrogen, an atom containing a nucleus with spin 1.

2. Quarks are components of some particles that interact very strongly, so that, for example, different ways of binding the same three quarks can have significantly different energies, enough different that they are given different names. At right is a complete list of those particles lighter

Name	Mass	Spin
Λ	1116	1/2
Σ^0	1193	1/2
Σ^{*0}	1384	3/2

than 1500 MeV/c^2 which are a combination of one quark each of type up, down, and strange. Each of these quarks has the same spin. The lowest energy (mass) baryons always have zero orbital angular momentum, but the "spin" of the baryon comes from the spin of the quarks. Explain why the list is the way it is; *i.e.*, why we have these three particles and no others. You will have to guess the spin of the quarks.