Phy403 Quantum Mechanics
First Homework Assignment
Due Friday April 11

Problem 1. **Page 343, Problem 9.1**. Hint: only $< \Psi_{210}|\hat{H}'|\Psi_{100} >$ is non-zero.

Problem 2. **Page 343/344, Problem 9.3**. This is a fairly hard problem. See me for help. The answer in the book is correct.

Problem 3. In an NMR experiment, $\vec{B}$ is fixed and set to a value of 5000 Gauss. The resonant energy for absorption by a sample of water is 21.2 MHz. What value for g of a proton does this data imply? For this problem, you just need to plug in the values.

Two State Systems

Problem 4. Consider a spin 1/2 particle. At time $t = 0$, the particle is in the state $S_z = +\hbar/2$.

a) If S_x is measured at $t = 0$, what is the probability of obtaining a value of $+\hbar/2$?
b) Suppose instead of the measurement of part a), the system is allowed to evolve in a magnetic field $\vec{B} = B_0\hat{i}$, which is a constant magnetic field in the +x-direction. What is the state of the system at time $t = T$?
c) At time t, S_x is measured. What is the probability that a value of $+\hbar/2$ is obtained?

Problem 5. Consider a general two state system. In a particular basis, the Hamiltonian matrix will have 4 elements: H_{11}, H_{12}, H_{21}, and H_{22}. For this problem we will consider the special case where $H_{11} = H_{22}$.

a) Use the constraint of Hermiticity of H to find the allowed values for the H_{ij}. How many different real numbers are needed to describe H?
b) Find the eigenvalues and eigenvectors for this general case (where $H_{11} = H_{22}$). Express your answers in terms of the real number variables that you used in part a).