PHYS 5382
Fall 2016
TE Coan
Due: 11 Nov '16 6:00 pm

Homework 6

0. Box your **entire** answer for each problem or lose points.

1. This is a bit of useful review. You will probably find the solution to HW1 problem 2 useful. A spin-$\frac{1}{2}$ particle, initially in a state with $S_n = \hbar/2$ with $\mathbf{n} = \cos\theta\,\mathbf{i} + \sin\theta\,\mathbf{k}$, is in a constant magnetic field B_0 in the z-direction. Determine the state of the particle after a time t and determine how $\langle S_x \rangle$, $\langle S_y \rangle$ and $\langle S_z \rangle$ vary with time. Box your answer.

2. Use the data from Fig 4.3 in Townsend to determine numerically the muon g-factor. Note that we have been using the SI system of units while the text uses the cgs system. To get the SI formula for the precision frequency ω_0 from the cgs system, substitute $c = 1$ into the text formula (or use the formula from lecture). Box your answer.

3. A beam of spin-$\frac{1}{2}$ particles with speed v_0 passes through a series of two SG**z** devices. The first SG**z** device transmits particles with $S_z = \hbar/2$ and filters out particles with $S_z = -\hbar/2$. The second device transmits particles with $S_z = -\hbar/2$ and filters out particles with $S_z = \hbar/2$. Between the two devices is a region of length l_0 in which there is a uniform magnetic field B_0 pointing in the x-direction. Determine the smallest value of l_0 such that exactly 25% of the particles transmitted by the first SG**z** device are transmitted by the second device. Express your **boxed** answer in terms of $\omega_o = egB_0/2m$ and v_0.

4. More review. Determine the eigenstates of $\hat{S}_x$ for a spin-1 particle in terms of the eigenstates $|1,1\rangle$, $|1,0\rangle$ and $|1,-1\rangle$ of $\hat{S}_z$. Box that answer.

5. Derive the so-called "Rabi formula" found in the text, Eq 4.45.

6. Calculate ΔS_x and ΔS_x for an eigenstate of $\hat{S}_z$ for a spin-$\frac{1}{2}$ particle. For specificity, you can choose $|+\mathbf{z}\rangle$ as the eigenstate for $\hat{S}_z$. Check if the uncertainty relation $\Delta S_x \Delta S_y \geq \hbar|\langle S_z \rangle|/2$ is satisfied. Show your calculation explicitly. Box the answer.