PHYS 4380 Quantum Mechanics I

Homework Assignment 07

Due date: November 01, 2018

Instructor: Dr. Daniel Erenso Name: _____

Mandatory problems: 3 & 5

Student signature:_____

Student Comment:_____
_____
_____

Problem #	1	2	3	4	5	Score
Score	/	/	/	/	/	/100

1. Townsend 4.4

2. Townsend 4.8, 4.9, & 4.10

3. Townsend 4.14

4. Townsend 3.23, 4.15, & 4.16

5. Consider an electron (charge, $q = -e$ and mass, m) with magnetic dipole moment $\vec{m}$. Somebody turned on a uniform magnetic field B_0 directed along the positive y-axis.

(a) Determine the classical Hamiltonian

(b) Determine the quantum Hamiltonian

(c) Solve the eigenvalue equation for the quantum Hamiltonian

(d) Determine the state of the electron at a later time t if the initially state of the electron, $|\psi(0)\rangle = |-Z\rangle$ and $|\psi(0)\rangle = |-X\rangle$.

(e) Using the state vector determined in (d) find the probabilities $P_{+z}(t)$ and $P_{-z}(t)$, $P_{+x}(t)$ and $P_{-x}(t)$ for both initial states.

(f) Find the expectation values for $\left\langle \hat{S}_z \right\rangle$, $\left\langle \hat{S}_x \right\rangle$, and $\left\langle \hat{S}_y \right\rangle$ when the electron is initially in the state $|\psi(0)\rangle = |-X\rangle$.

(g) Verify the results you determined in (f) using the Heisenberg equation.

6.

(a) One application of precession of spin-1/2 particle in a magnetic field is in measurement of g from the equation

$$\omega_0 = \frac{geB_0}{2m_e c}. \tag{1}$$

for the Muon. Read the text and briefly summarize how precession of spin-1/2 particle is used to experimentally measure g.

(b) Read the handout (from Feynman lecture) about the Ammonia molecule and Ammonia maser. Write a summary of what you understood in relation to what you have introduced about quantum mechanics up to this point.