Physics 460—Assessment S–2 Name: ____________

S–2: I can analyze systems with intrinsic angular momentum (spin).

Unsatisfactory Progressing Acceptable Polished

In the z-state basis the spin operators are, for the case $s = 1$,

$$S_z \leftrightarrow \hbar \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{bmatrix}, \quad S_x \leftrightarrow \frac{\hbar}{\sqrt{2}} \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}, \quad S_y \leftrightarrow \frac{\hbar}{\sqrt{2}} \begin{bmatrix} 0 & -\mathrm{i} & 0 \\ \mathrm{i} & 0 & -\mathrm{i} \\ 0 & \mathrm{i} & 0 \end{bmatrix},$$

and the eigenstates of S_x and S_y are

$$|{+1_x}\rangle \leftrightarrow \frac{1}{2} \begin{bmatrix} 1 \\ \sqrt{2} \\ 1 \end{bmatrix}, \qquad |0_x\rangle \leftrightarrow \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 0 \\ -1 \end{bmatrix}, \qquad |{-1_x}\rangle \leftrightarrow \frac{1}{2} \begin{bmatrix} 1 \\ -\sqrt{2} \\ 1 \end{bmatrix},$$

$$|{+1_y}\rangle \leftrightarrow \frac{1}{2} \begin{bmatrix} 1 \\ \sqrt{2}\mathrm{i} \\ -1 \end{bmatrix}, \qquad |0_y\rangle \leftrightarrow \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}, \qquad |{-1_y}\rangle \leftrightarrow \frac{1}{2} \begin{bmatrix} 1 \\ -\sqrt{2}\mathrm{i} \\ -1 \end{bmatrix}.$$

(1) A spin-1 particle in state $|{+1_z}\rangle$ is placed in a magnetic field $\vec{B} = B_0\,\hat{\jmath}$. The Hamiltonian for the particle is then $H = -\gamma \vec{S} \cdot \vec{B}$, where γ is a constant.

If you were to measure the z-component of the spin at time $t = 0$, you would obtain the value $+\hbar$ with probability 1. Find the later times t that you could obtain the value $-\hbar$ for this measurement with probability 1.