A particle with spin S=1 has spin operators S_x and S_z represented by the 3 x 3 matrices:

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$$S_z = \hbar \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}, S_x = \frac{\hbar}{\sqrt{2}} \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

(a) Determine the 3 x 3 matrix representing the spin operator S_y for this spin 1 particle.

(b) The spin state for this particle is generally represented by a column vector

$$\psi = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

Determine a, b, and c such that the spin state ψ is normalized and corresponds to the maximum possible value of S_x.

(c) Now, consider a magnetic field B pointing in the +z direction. Assume that the spin 1 particle has a magnetic moment μ, and at t=0 is placed in the magnetic field such that its initial spin state is that given in part (b), i.e., it is polarized along the +x direction. Find the spin state ψ at later times.

(d) What is the probablility that the spin state of the particle will be polarized along the +x direction at a time later than t=0?

Useful information: For a general angular momentum state

$$|\,j, m>, (J_x \pm iJ_y)|j, m> = \hbar\sqrt{(j \mp m)(j \pm m + 1)}\,|j, m \pm 1>$$