# HW10: Physics 115A

**Problem 5.38** The Hamiltonian for a certain three-level system is represented by the matrix

$$H = \hbar\omega \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{pmatrix}.$$

Two other observables, $A$ and $B$, are represented by the matrices

$$A = \lambda \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 2 \end{pmatrix}, \quad B = \mu \begin{pmatrix} 2 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix},$$

where $\omega$, $\lambda$, and $\mu$ are positive real numbers.

(a) Find the eigenvalues and (normalized) eigenvectors of $H$, $A$, and $B$.

(b) Suppose the system starts out in the generic state

$$|\mathcal{S}(0)\rangle = \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix},$$

with $|c_1|^2 + |c_2|^2 + |c_3|^2 = 1$. Find the expectation values (at $t = 0$) of $H$, $A$, and $B$.

(c) What is $|\mathcal{S}(t)\rangle$? If you measured the energy of this state (at time $t$), what values might you get, and what is the probability of each? Answer the same questions for $A$ and for $B$.