1. Explain the key features of a Stern-Gerlach experiment
   - Relate the magnetic moment to spin angular momentum
   - Explain the classical prediction and how it is different from experimental results.

2. Express a quantum state as a linear combination of eigenstates and interpret the expansion coefficients as probability amplitudes
   a) for Spin-1/2, Spin-1, a particle in a box, and a general quantum system
   b) Distinguish values that are measured, states after a measurement, and probabilities of measuring values
   c) Relate the eigenstates for different spin components $\hat{S}_x$, $\hat{S}_y$, $\hat{S}_z$, $\hat{S}_n$
   d) Normalize the state
   e) Determine a quantum spin-1/2 state from the results of experiments.
   f) Calculate measurement probabilities given a quantum state
   g) Describe the role of relative and overall phase is distinguishing quantum states

3. Express quantum states and perform quantum calculations in matrix, Dirac, or wavefunction notation, as appropriate
   a) Translate between matrix, Dirac, wavefunction, and histogram representations correctly
   b) Change bases in Dirac notation using a completeness relation
   c) Calculate matrix elements of operators
   d) Calculate expectations values and uncertainty
   e) Calculate the probability of finding a quantum particles to be in some region of space
   f) Calculate the probability of measuring a particular value of an observable.
   g) Determine if two complex valued vectors are orthogonal to each other

4. Interpret and predict the probabilistic outcomes of sequential Stern-Gerlach experiments, including a quantum interferometer
   a) Distinguish mixed vs. superposition states and explain how you can experimentally distinguish them
   b) Mathematically model the collapse of the quantum state using projection operators
   c) Mathematically model the coherent superposition of quantum states in a quantum interferometer

5. Describe the relationship between operators and observables

a) Relate possible measurement values and possible states after a measurement to the eigenvalues & eigenvectors of Hermitian operators

b) Determine energy eigenvalues and eigenstates from a Hamiltonian

c) Determine spin components/total spin and spin eigenstates from spin operators

d) Determine possible measurement values and possible states after a measurement from an operator that represents an observable

e) Describe the relationship between the eigenstates of observables that commute

6. Determine the time evolution of a spin quantum system or particles in an infinite or finite 1D potential well given a time-indepedent Hamiltonian and the initial state of the system

   a) Write down the Hamiltonian for a spin system in a uniform magnetic field

   b) Write down the Hamiltonian for a particle in an infinite square well

   c) Identify stationary states and when probabilities will not change with time.

   d) Use time-evolved states in calculations (e.g., expectation value)