1. Consider a spin-1/2 system

   a) In Dirac notation, write down all the eigenvalue equations for the S_z operator.

   b) Represent the following spin-1/2 state:

   $$|\psi_a\rangle = |+\rangle_y$$

      i. in Dirac notation using the S_z basis.
      ii. with Arms in the S_z basis.
      iii. as a column matrix in the S_z basis.
      iv. as a S_z probability histogram.

2. Consider a spin-1 system under the influence of a Hamiltonian $\hat{H} = \omega\hat{S}_n$.

   a) In Dirac notation, write down all the eigenvalue equations for the Hamiltonian.

   b) Represent the following spin-1 state:

   $$|\psi_b\rangle = |1\rangle$$

      i. in Dirac notation using the energy basis.
      ii. with Arms in the energy basis.
      iii. as a column matrix in the energy basis.
      iv. as a energy probability histogram.

3. Consider a spin-2 system with 5 possible values for spin components: $2\hbar, \hbar, 0\hbar, -\hbar, -2\hbar$.

   a) In Dirac notation, write down all the eigenvalue equations for the $\hat{S}_z$ operator.

   b) Represent the general state $|\psi_c\rangle$:

      i. in Dirac notation using the S_z basis.
      ii. with Arms in the S_z basis.
      iii. as a column matrix in the S_z basis.
      iv. as a S_z probability histogram.

4. Consider a quantum system where the position of the particle is something you can measure:

   a) In Dirac notation, write down all the eigenvalue equations for the $\hat{x}$ operator.

   b) Represent the state $|\psi_d\rangle$:

      i. in Dirac notation using the position basis.
      ii. with Arms in the position basis.
      iii. as a column matrix in the position basis.
      iv. as a probability density graph.