For these questions, use the simulation "Semi-classical vector model of orbital angular momentum" and work through the simulation, including the step-by-step exploration (click on the "Step-by-step Exploration" tab).

1) State differences between orbital angular momentum of a classical particle and a quantum particle.

2) a) Assume a quantum particle is in a state with orbital quantum number $l = 3$ and magnetic quantum number $m = 2$. What do these two quantum numbers tell you about the orbital angular momentum of the particle? Explain how l and m relate to the length and direction of the vector shown in the simulation for these quantum numbers. Explain why a cone is a better representation for the orbital angular momentum than a single vector.

b) How many different orientations in space (each only defined up to a cone with fixed opening angle) would there be for the orbital quantum number $l = 6$? Generalize your result. How many different orientations are there for an arbitrary quantum number l?

c) Make a sketch similar to the ones shown in the simulation showing all possible orientations of the angular momentum vector for $l = 6$. You do not need to draw the cones. Explain how you are determining the directions of the vectors in your sketch. Label the vectors by their magnetic quantum numbers m.

3) a) Consider a *classical* (incorrect) model of hydrogen consisting of an electron orbiting a proton in a circular orbit in the xy plane. In an xyz coordinate system, sketch the orbit and the angular momentum vector. Assume the magnitude of orbital angular momentum of the electron is L. What can you say about the z-component of orbital angular momentum L_z?

b) Explain why for a quantum particle the value of the z-component of angular momentum L_z must always be less than the magnitude of angular momentum L.