Chapter 36 Problem 40 †

Given
$E = -0.850\ eV$

Solution
a) Find the maximum magnitude of orbital angular momentum.

The principle quantum number is tied to the energy of the electron. For the hydrogen atom this is given by the formula

$$E_n = \frac{-13.6\ eV}{n^2}$$

Solving for n gives

$$n = \sqrt{\frac{-13.6\ eV}{E_n}}$$

Substituting in the appropriate values gives

$$n = \sqrt{\frac{-13.6\ eV}{-0.850\ eV}} = \sqrt{16} = 4$$

The maximum value of orbital quantum number for this electron is

$$l = n - 1 = 4 - 1 = 3$$

The magnitude of the orbital angular momentum is then

$$L = \sqrt{l(l+1)}\hbar = \sqrt{3(3+1)}\hbar = \sqrt{12}\hbar$$

b) Find the maximum component of that angular momentum on a given axis.

The values of the magnetic quantum number can range from $-l$ to $+l$. Since $l = 3$ for this electron, the values of m_l can be $-3,\ -2,\ -1,\ 0,\ +1,\ +2,\ +3$. The maximum angular momentum along a particular axis is then

$$L_z = m_l\hbar = 3\hbar$$

†Problem from Essential University Physics, Wolfson