Chapter 36 Problem 35 †

Given
$E = -0.850\ eV$
$L = \sqrt{12}\hbar$

Solution
Find the principle and orbital quantum number for a hydrogen atom with an electron with energy and angular momentum as given above.

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 magnitude of the angular momentum is given by the formula

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

Solving for l gives

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

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

$$12 = l(l+1)$$

$$l^2 + 1 - 12 = 0$$

$$(l+4)(l-3) = 0$$

$$l = 3, -4$$

Since l can not be negative, then

$$l = 3$$

†Problem from Essential University Physics, Wolfson