PHYSICS 4, CHAPTER 4
ADDITIONAL PROBLEMS

1. For the hydrogen atom in its ground state, calculate
(a) the probability density? and
(b) the radial probability density P(r) for r = a, where a is the Bohr radius.

ANSWER: (a) 291 nm^{-3}; (b) 10.2 nm^{-1}

2. (a) What is the wavelength of light for the east energetic photon emitted in the Lyman series of hydrogen atom spectrum lines?
(b) What is the wavelength of the series limit for the Lyman series?

ANSWER: (a) 122 nm; (b) 91.1 nm

3. What are the (a) energy,
(b) magnitude of the momentum, and
(c) wavelength
of the photon emitted when a hydrogen atom undergoes a transition from a state with n = 3 to a state with n = 1?

ANSWER: (a) 12.1 eV; (b) 6.45×10^{-27} kg.m/s; (c) 102 nm

4. How much work must be done to pull apart the electron and the proton that make up the hydrogen atom if the atom is initially in
(a) its ground state and
(b) the state with n = 2?

ANSWER: (a) 13.6 eV; (b) 3.40 eV

5. What is the probability that in the ground state of the hydrogen atom, the electron will be found at a radius greater than the Bohr radius?

ANSWER: 0.68

6. (u) How many l values are associated with n = 3?
(b) How many m_l values are associated with l = 1?

ANSWER: (a) 3; (b) 3

7. (a) For a given value of the principal quantum number n, how many values of the orbital quantum number l are possible?
(b) For a given value of l,, how many values of the orbital
magnetic quantum number m_l are possible?
(c) For a given value of n, how many values of m_l are possible?

ANSWER: (a) n; (b) $2l + 1$; (c) n^2

8. (a) What is the magnitude of the orbital angular momentum in a state with l = 3?
(b) What is the magnitude of its largest projection on an imposed z axis?

ANSWER: (a) 3.65×10^{-34} J.s; (b) $3 .16 \times 10^{-34}$J.

9. An electron in a hydrogen atom is in a state with l = 5. What is the minimum possible value of the semiclassical angle between $\vec{L}$ and L_z?

ANSWER: 24.1^o

10. Two of the three electrons in a lithium atom have quantum numbers (n, l , m_l, m_s) of (1, 0, 0, + l/2) and (1, 0, 0, -1/2). What quantum numbers are possible for the third electron if the atom is
(a) in the ground state and
(b) in the first excited state?

ANSWER: (a) (2, 0, 0, +1/2), (2, 0,0, - 1/2) ;
(b) (2, 1, 1, +1/2), (2, 1, 1, -1/2), (2, 1, 0, +1/2), (2, 1, 0, -1/2), (2, 1, -1, +1/2), (2, 1, -1,-1/2)