Learning Objectives and Worksheet II

Chemistry 1B-AL Fall 2016

~~Lectures~~ (3-4) the Quantum Mechanics of the Hydrogen Atom and Atomic Orbitals

Read pp. 537-542 and 549-557 *(you will not be responsible for the material on pp-543-549; however the CHEM1B-AL staff would be more than happy to discuss these concepts with you)*

I. Regarding the "allowed states" of the Bohr hydrogen atom:
   1. What features of the Bohr treatment of the hydrogen are correct?

   2. What feature is inconsistent with the wave properties of the electron?

II. Although you will have to await the charms of CHEM 163A "Quantum Mechanics And Basic Spectroscopy" to fully understand and solve the basic equation that gives the properties of electrons in atoms and molecules, CHEM1B students should have an acquaintance with:
   1. What is the name of the famous equation of quantum mechanics that yields the properties of the allowed states of electrons in atoms and molecules?

      _____
   2. When this equation is solved for a particular atom or molecule two important aspects of the solutions for the are:

      i. the _____ of the allowed state

      ii. and the _____ which is related to the _____ of finding the electron at various positions in space

III. The solutions of the Schrödinger equation for the allowed states of the electron in the hydrogen atom are:
   1. characterized by three integer quantum numbers _____, _____, and _____

2. the values that these integers can take are:

   i. n = _____

   ii. for a given n ℓ = _____

HW#1 **10, 11, 12**

   iii. for a given ℓ m_ℓ = _____

   iv. the "names" for different values of ℓ are ℓ=0 ___ , ℓ=1___ , ℓ=2___ , ℓ=3___

   v. thus for n=3 there would be _____ different orbitals.

IV. The properties of the allowed states are:

1. In the hydrogen atom, all states with the same _____ have the same energy. States with differing quantum numbers, but which have the same energy, are called _____ states.

2. Properties of an electron in orbital Ψ n,ℓ,mℓ associated related to each of the three quantum numbers are:

HW#2 **9**

   i. n:

   ii. ℓ:

   iii. m_ℓ:

3. Shapes of the orbitals:

   i. Be familiar with the shapes of the radial and angular components of the s, p, and d orbitals pictured in the text and in the handouts and the various ways that orbitals and related electron densities are graphically portrayed.

   ii. The + and – values associated with a diagram of an orbital give which *(cross out incorrect and circle correct choice)*:
   the + or - electronic charge in that region of the orbital-?
   or
   the relative phase or sign (±) of the probability wave in that region of the orbital

   iii. How do the quantities Ψ^2 and $4\pi r^2\Psi^2$ differ in describing electron density in an orbital?

HW#1 **13**

iv. What do the three quantum numbers n, ℓ, and m_ℓ indicate about the shape of the hydrogen orbital:


HW#2 **14,15**

a. the orbital will have _____ radial nodes
b. the orbital will have _____ angular nodes
c. the different m_ℓ values correspond to differing _____ of the _____ (how many) orbital components

Simulation of the spectrum of the H-atom:
http://phys.educ.ksu.edu/vqm/html/h2spec.html
Simulation of Wave-function probability:
http://phys.educ.ksu.edu/vqm/html/probillustrator.html
Hydrogen orbitals: Java simulator to make models:
http://www.falstad.com/qmatom/index.html
Shockwave movie:
http://www.colby.edu/chemistry/OChem/DEMOS/Orbitals.html
Orbital viewer: http://www.orbitals.com/orb/ov.htm