UNIVERSITY OF THE WEST INDIES
DEPARTMENT OF CHEMISTRY

C10J ATOMIC STRUCTURE (Tutorial #2)

1. How much energy (in Joules) would be needed to excite an electron from the n = 1 to the n = 2 level in the hydrogen atom?

2. Calculate the ionization energy [in Joules and in eV (electronvolts)] for the hydrogen atom.

3. Calculate the de Broglie wavelength of
   (a) an electron with a velocity of half the speed of light, and
   (b) a 60-kg man running the 100 m dash in 10.0 seconds.

4. Give diagrams of the radial wavefunction, R, and the square of the radial wavefunction, R^2, against r, the electron-nucleus distance for the 1s, 2s and 2p orbitals of the hydrogen atom.

5. Give diagrams of the radial distribution function (RDF), $4\pi r^2R^2$, against r, the electron-nucleus distance for the 1s, 2s and 2p orbitals of the hydrogen atom.

6. The general expression for the mean radius of an orbital with quantum numbers *n* and *l* is

$$\langle r \rangle = \left\{1 + \frac{1}{2}\left(1 - \frac{l(l+1)}{n^2}\right)\right\}\frac{n^2 a_o}{Z}$$

   where a_o is the Bohr radius (= 0.5292 Å). Evaluate <r> for the 3s and the 3p orbitals on the hydrogen atom. Explain the difference in the values obtained.

7. A wave function has two parts, an angular part and a radial part. The hydrogenic radial wavefunction for a 1s orbital is given as

$$R = 2\left(\frac{Z}{a_o}\right)^{\frac{3}{2}} e^{-\frac{1}{2}\rho}$$

   Where $\rho = 2Zr/na_o$ and Z = atomic number. For the hydrogen 1s orbital, plot on graph paper, values of R against r for values of r = 0.2 a_o, 0.4 a_o, 0.6 a_o, … 1.2 a_o.

8. What do you understand by the orbital approximation as applied to the ground state Helium atom?

PTM