CHEM 131 Name ____

Quiz 1 – August 28, 2019

Complete the following problems. Write your final answers in the blanks provided. You must show your work to receive full credit. Show your answers to the correct number of significant figures with the correct units.

1. Consider light with wavelength of 410 nm.
   a. What is the energy of a photon of this light? (4 pts)

$$\lambda = 410 \text{ nm} = 4.10 \times 10^{-7} \text{ m}$$

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J } \cancel{\text{s}})(2.998 \times 10^{8} \cancel{\text{m}}\,\cancel{\text{s}^{-1}})}{4.10 \times 10^{-7} \cancel{\text{m}}} = 4.845\text{x}10^{-19} \text{ J}$$

Answer_____4.8x10^{-19} J_____

   b. An electronic transition in a hydrogen atom, starting at $n_i = 7$, produces light of 410 nm wavelength. What is the final n for this transition? REMEMBER: n is an integer! (5 pts)

$$\Delta E = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \text{ or } 4.8 \times 10^{-19}\text{J} = 2.179 \times 10^{-18}\text{J}\left(\frac{1}{n_f^2} - \frac{1}{7^2}\right)$$

$$\frac{4.8 \times 10^{-19} J}{2.179 \times 10^{-18}\text{J}} + \frac{1}{49} = \frac{1}{n_f^2}$$

$$0.2203 + 0.02041 = 0.24069 = \frac{1}{n_f^2}$$

$$n_f = \sqrt{\frac{1}{0.24069}} = 2.04$$

Answer______2_____________

2. Determine if each of the sets of quantum numbers below is **valid** or **invalid**, given the rules of quantum mechanics. For each set that is **invalid** provide a brief explanation of what makes the set invalid. (8 points)

   a. $n = 3$, $\ell = 3$, $m_\ell = 1$ **invalid**

   ℓ is limited in values from 0 to n-1, so for n=3, the maximum value of ℓ is 3-1 = 2.

   b. $n = 3$, $\ell = 1$, $m_\ell = -1$ **valid**

   This is a 3p orbital

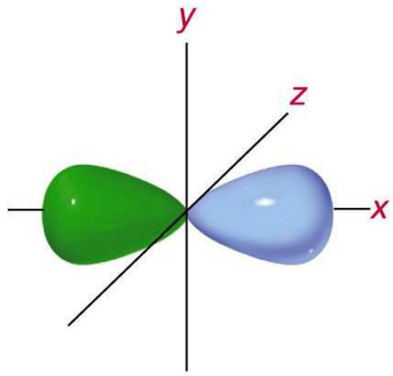
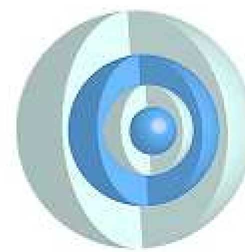
   c. $n = 3$, $\ell = 2$, $m_\ell = 3$ **invalid**

   m_ℓ is limited in values from -ℓ to +ℓ, so for ℓ = 2, m_ℓ can only be -2, -1, 0, +1, +2.

   d. $n = 2$, $\ell = 0$, $m_\ell = 0$ **valid**

   This is a 2s orbital

3. Sketch an example of each of the two orbitals below. For each orbital indicate the number of radial and angular nodes. (8 pts)

Orbital	$n = 2$, $\ell = 1$	$n = 4$, $\ell = 0$
Sketch	**This is a 2p orbital. Your sketch should resemble this, orientation is not critical, only the shape.** 	**This is a 4s orbital. Your sketch should resemble this. Two-dimensional or 3 dimensional sketch is OK, as long as correct # of nodes are shown.** 
Number of Radial Nodes	**0**	**3**
Number of Angular Nodes	**1**	**0**

Possibly Useful Information

$h = 6.626 \times 10^{-34}$ J s	$c = 2.998 \times 10^{8}$ ms^{-1}	$E = h\upsilon = \dfrac{hc}{\lambda}$	$\Delta E \bullet \Delta(mv) > h$
$R_H = 2.179 \times 10^{-18}$ J/atom	$E = -\dfrac{R_H}{n^2}$	$\Delta E = R_H\left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right)$	$H\psi = E\psi$