**CH301 Fall 2008 Worksheet 2—Nice preparation for Quiz 1 on the first half of Chapter 1**

1. From memory (to the best of your ability), write all regions of the electromagnetic spectrum discussed in class in order from longest to shortest wavelength.

2. Now write the same regions of the electromagnetic spectrum in order from highest to lowest energy.

3. If asked to write the spectrum in order from highest to lowest frequency, would they be written in the same order as in question 1or question 2? Explain your reasoning.

4. Consider light with a wavelength of 470 nm.

a. What color of visible light would this correspond to?

b. What would the frequency of this light be?

c. How much energy would a single photon of this light posses? Express your answer in joules.

d. How much energy would a mole of such photons posses? Express your answer in kilojoules per mole.

5. If the average bond energy for the O-H bond in water is 458.9 $kJ \cdot mol^{-1}$, what is the minimum frequency of light necessary to break that bond?

6. What failed prediction made by classical mechanics about the nature of electromagnetic radiation lead to the ultraviolet catastrophe?

7. What is the photoelectric effect? How did it demonstrate the inadequacy of the classical mechanical

description of light?

8. What is the de Broglie wavelength of a standard round fired from a Mauser C96? A standard round would have a mass of 5.6 g and an initial velocity of 430 $m \cdot s^{-1}$.

9. What would the relativistic (hypothetical) mass of a photon of red (700 nm) light in a vacuum be?

10. Using the relativistic mass of the photon calculated above, and the equation $E = mc^2$, calculate the energy of that photon. Compare that value to the value derived using Planck's relation.

11. What is the minimum uncertainty in the position of an electron (mass = $9.11 \times 10^{-31}$ kg) traveling at a velocity with an uncertainty of $3.0 \times 10^{7}$ $m \cdot s^{-1}$?

12. If scientists wanted to calculate the mass of a newly discovered subatomic particle for which they had only position ($\Delta x = 3.313 \times 10^{-9}$ m) and velocity ($\Delta v = 2.0 \times 10^{6}$ $m \cdot s^{-1}$) data, what would that mass be. Why is this a bad method to calculate a particle's mass?

13. From memory (to the best of your ability) list all possible values (the boundary conditions) for the quantum numbers $n$, $l$, $m_l$, $m_s$.

14. Determine whether the following sets of quantum numbers are valid. If you determine they are invalid, explain your reasoning

a. $n = 3$, $l = 0$, $m_l = 0$, $m_s = +½$

b. $n = 3$, $l = 2$, $m_l = -2$, $m_s = +1$

c. $n = 0$, $l = 0$, $m_l = 0$, $m_s = +½$

d. $n = 2$, $l = 2$, $m_l = -1$, $m_s = -½$

e. $n = 4$, $l = 3$, $m_l = +4$, $m_s = -½$

15. Suggest possible values for quantum numbers that could fill in the blanks below without violating any boundary conditions.

a. $n = 3$, $l = 0$, $m_l =$ ___, $m_s = +½$

b. $n = 6$, $l =$ ___, $m_l = +3$, $m_s = +½$

c. $n = 2$, $l = 1$, $m_l = -1$, $m_s =$ ___

16. State the Aufbau principle in your own words. Without consulting a table, your notes or any peers, write the Aufbau order. (Hint: you can read the Aufbau order right off the periodic table.)

17. State Hund's rule in your own words.

18. State the Pauli exclusion principle in your own words.

19. Using quantum numbers, describe:

a. The highest energy electron in a Boron atom.

b. The lowest energy electron in a Xenon atom.

20. What is an element that can have a ground state electron described by the quantum numbers:
$n = 7$, $l = 1$, $m_l = 1$, $m_s = +½$