Chemistry Worksheet Name: ____________________________

Quantum Concepts – Quantized States and Electromagnetic Energy Block: ___________

Answer each question in the space required. Show all work.

1. The simplest problem in quantum mechanics is called the "particle in a one-dimensional box." The expression for the energy of a particle in the n^{th} quantum state in a one-dimensional (infinite-well) box is as follows:

$$E_n = \frac{n^2 h^2}{8mL^2}$$

where m is the mass of the particle, h is Planck's constant, and L is the length of the box. The particle, which is originally in the $n = 2$ quantum state, transits to the $n = 1$ quantum state.

a. **Derive** an expression for the **wavelength** of the electromagnetic radiation that is emitted as a result of that transition. (Hint: find ΔE – use algebra!)

b. Generalize your result from the previous question to accommodate transitions between any two energy levels, $n_{initial}$ and n_{final}.

c. An electron is confined in a box of that is exactly 5 nm long. Use your formula from the previous question to calculate the *emission spectrum* that would arise from all initial higher energy states up to $n_i = 6$ that end up at $n_f = 1$. Sketch the spectrum that results at the bottom of the page.

2. Use the space below to draw an energy level diagram for the **helium ion** (He^+). Use a ruler to make the straight lines, instead of drawing free-hand! Include 5 energy levels – the ground state and the first 4 excited states – calculate the energy for each of these states, and write these values in (3 significant figures) along the left energy axis. Draw in all possible electron transitions that represent emission of light from level 5. Calculate the wavelength for each of these transitions, and write it by each transition.