Creating the Hydrogen Spectrum

The energy levels of hydrogen are given by the equation

$$E_n = 13.6\left(1 - \frac{1}{n^2}\right),$$

for a given energy level, n. The units of E_n are electronvolts (eV), a unit of energy that operates on an order of magnitude consistent with the energies of electron levels in atoms. We can also determine the wavelength of a particular electron transition by using the Rydberg formula:

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right),$$

where n_1 and n_2 are two different levels with n_2 being the higher one, λ is the wavelength in meters, and $R_H = 1.097 \times 10^7/\text{m}$ is the Rydberg constant.

With this information, we can see where the hydrogen spectrum comes from. To do this, please complete the following steps on another piece of paper:

1. Remembering that the lowest level is n=1, calculate the first six energy levels for hydrogen. (8 points)
2. Using a scale of 1 cm/eV and a ruler, draw a picture showing how far apart your calculated energy levels are from one another. To do this, draw a horizontal line to represent the ground state (n=1) and measure above it to place the other levels. The values for E_n that you calculated are all measured above the first level. (2 points)
3. Label each level with your calculated energy value. (2 points)
4. Pick any three electron transitions with at least 2 different n_1 values and calculate the wavelength you expect to see as a result of the transition by using the Rydberg formula. (5 points)
5. On your picture, graphically indicate which transitions you calculated and label your symbols with the values you got. (3 points)
6. Which energy levels will be involved in high-energy transitions? Low energy? Which end of the spectrum will photons from these transitions live in? (4 points)

Please be sure to **staple** and turn in *all* of your work. Full Credit will not be awarded for answers alone and partial credit can only be granted if you show every step of your work in a clear manner. Each aspect of the project is worth the indicated number of points, resulting in a total of 20 points for the in-class component, and 24 points for the hydrogen spectrum component.