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CHM. 121.004
Inst. Mark Novak
Lab Report – Experiment 8
11/2/17

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Experiment Objective

The objective of this experiment was to measure visible wavelengths of a hydrogen spectrum using a device called the MiniSpectromter. With the data we collected using the spectrometer, we were also required to calculate the values of the energy levels, calculate the energy difference of the transitions, and draw an energy level diagram.

Conclusion

There is not much that can be said about this experiment. The experiment took about 20 minutes and was fairly simple. My lab partner and I followed the procedure and obtained our data from the computer. We then noticed there was a good amount of "noise," so we repositioned the probe closer to the hydrogen tube and obtained our data for a second time. We still had a little bit of "noise" in our data collection graph but it was far less than our first data collection. Doing the calculations took more time than the actual experiment. For the 1st peak, we measured a wavelength of 656 nm and calculated an n_{hi} of 3. For the 2nd peak, we measured a wavelength of 486 nm and calculated an n_{hi} of 4. For the 3rd peak, we measured a wavelength of 434 nm and calculated an n_{hi} of 5. For the 4th peak, we measured a wavelength of 410 nm and calculated an n_{hi} of 6.

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ADVANCE STUDY ASSIGNMENT

Working with the Balmer Equation

Use the Balmer equation to calculate the four wavelengths in the visible light range for the hydrogen gas emission. Record your information in the data table below. The calculated wavelengths should give you a strong clue as to the color of the four emission lines.

n_i or n_{hi}	n_f or n_{lo}	λ (nm)	Color
3	2	656	Dark Red
4	2	486	Blue - Green
5	2	434	Blue
6	2	410	Dark Blue or Purple (Almost Black)

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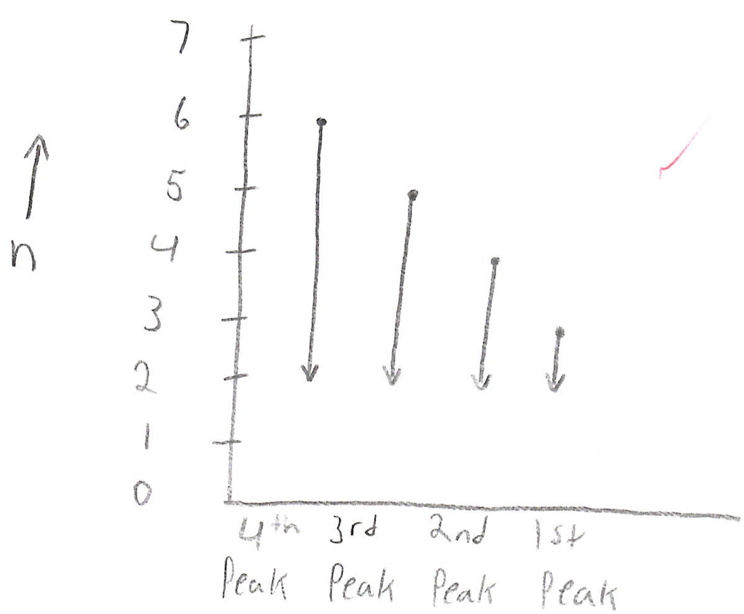
DATA TABLE

Hydrogen Spectrum

	Wavelength (λ) in nm	ΔE in kJ/mole	Decimal	n_{lo}	n_{hi}
1st Peak on the right- Red	656	182.317	.139	2	3
2nd Peak - Blue-ish – Green	486	246.091	.188	2	4
3rd Peak - Blue	434	275.576	.210	2	5
4th Peak, (last peak on the left) - Purple (almost black)	410	291.707	.222	2	6

Energy Level Diagram:



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$$\text{decimal} = \frac{1}{n_{io}^2} - \frac{1}{n_{hi}^2}$$

$$4x^2(d) = \left(\frac{1}{2^2} - \frac{1}{x^2}\right)4x^2$$

$$4dx^2 = x^2 - 4$$

$$4dx^2 - x^2 + 4 = 0$$

$a = 4d - 1$

$b = 0$

$c = 4$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-0 \pm \sqrt{0^2 - 4(4d-1)4}}{2(4d-1)}$$

$$= \frac{\sqrt{-16(4d-1)}}{2(4d-1)}$$

$$= \frac{\sqrt{16} \cdot \sqrt{-(4d+1)}}{2(4d-1)}$$

$$= \frac{\overset{2}{\cancel{4}} \cdot \sqrt{-(4d+1)}}{\cancel{2}(4d+1)}$$

$$= \frac{\pm 2\sqrt{-(4d+1)}}{(4d-1)}$$

$$= \frac{\pm 2\sqrt{-(4d+1)}}{-(-4d+1)}$$

$$= \frac{2\sqrt{-4d+1}}{-4d+1}$$

$$\text{1st Peak} = \frac{2\sqrt{-4(.139)+1}}{-4(.139)+1}$$

$$\boxed{\text{1st peak} = 3}$$

$$\text{2nd Peak} = \frac{2\sqrt{-4(.188)+1}}{-4(.188)+1}$$

$$\boxed{\text{2nd Peak} = 4}$$

$$\text{3rd Peak} = \frac{2\sqrt{-4(.210)+1}}{-4(.210)+1}$$

$$\boxed{\text{3rd Peak} = 5}$$

$$\text{4th Peak} = \frac{2\sqrt{-4(.222)+1}}{-4(.222)+1}$$

$$\boxed{\text{4th Peak} = 6}$$

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QUESTIONS

1) Is the spectrum of an element limited only to the visible region of the electromagnetic spectrum? Discuss briefly.

No. The electromagnetic spectrum covers everything from Gamma rays to Audio frequency. The visible region is only a portion of the electromagnetic spectrum.

2) What is the difference in the energy change of the electrons, between absorption spectroscopy and emission spectroscopy?

In absorption, the electron gains energy to go from a lower energy level to a higher energy level. Energy will be absorbed.

In emmision, the electron releases energy to go from a higher energy level to a lower energy level. Energy will be released.

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3) Calculate the energy needed to cause an electron in the hydrogen atom to move from the energy level characterized by your experimental value of n_{lo} to a value of n_{hi} approaching ∞. What physical behavior in the hydrogen atom does such a transition represent?

327897.9 ~~kJ~~ J/mole too many sig figs −1

What physical behavior? Ionization ✓

$$\Delta E = -2.178 \times 10^{-18}\ J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$= (-2.178 \times 10^{-18})\left(-\frac{1}{4}\right)(6.022 \times 10^{23})$$

$$= 327897.9$$

4) Calculate the energy needed to raise an electron from n_{lo} = 1 to n_{hi} = ∞. Thus, calculating the ionization energy of hydrogen. Express your result in kilojoules per mole. (You may be able to compare this with a value in your text to see if you are correct.)

1.313×10^{3} kJ/mole

$$\Delta E = -2.178 \times 10^{-18}\ J\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right)$$

$$(1 - 0)$$

$$= (-2.178 \times 10^{-18})(1)(6.022 \times 10^{23})$$

$$= -1.313 \times 10^{3}$$

Spectrum from DiVA2 spectrometer

rcDiVA Spectrum2, Friday, October 27 2017, 11:19

Integration time 200 ms, high gain, averaged over 10 readings.