# Examination of the Spectrum of Hydrogen

**Name:**_____ **Section:** _____

**Date:** _____

**Purpose:**

**DATA**

Record the number of lines per cm for the grating device you used: _____ .

Record the average $\Delta\theta$ for each line and calculate the rest of the values paying attention to significant figures and units (**1aJ = 1 *x* $10^{-18}$ J**).

| Line | average $\Delta\theta$ (degrees) | sin($\Delta\theta$) | $\lambda$ (cm) | $\Delta$E (aJ) | $n_i \rightarrow n_f$ |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |

**Preparation of your graph to determine $R_E$:**

The data you have tabulated will be used to determine the Rydberg constant. All of the lines that you observed (with your eyes) fall in the visible region of the EMR spectrum. If you check your prelab answers, you will see that these observable lines result from transitions from energy level $n_i > 2$ to energy level $n_f = 2$. Since this is true, we can simply use a graph to determine $R_E$. The graph we will prepare will have the form:

$$\Delta E = R_E\left(\frac{1}{{n_i}^2}\right) - \frac{R_E}{{n_f}^2}$$

To prepare the graph in Excel, read the appendix in your lab manual. A graph of $\Delta$E (aJ) vs. $(1/n_i^2)$ will have a slope of $R_E$, according to the equation shown above. Since you used aJ (attojoule) units, you need to convert the $R_E$ units back to J. You should also note that the y-intercept can also be used to find $R_E$. Read the post-lab questions and complete them prior to printing your graph; make sure that you printed the equation of the trendline and $R^2$ value on your graph.

**ATTACH THE GRAPH TO YOUR REPORT.**

**Find $R_E$ from both the slope and the y-intercept of the plot.**

Value from slope: _____

Value from y-intercept: _____

**Find the percentage difference between these two numbers.**

Percentage difference: _____

**Find the percentage error of each of these from the value computed from the fundamental constants (see your pre-lab).**

Accepted value of $R_E$ computed (see prelab): _____

% error of value from the slope: _____

% error of value from the intercept: _____

**Post Lab Questions:**

1. Some might say that Balmer got lucky when he examined the four visible lines from the emission spectrum of hydrogen. After all, the four colors (wavelengths) of light that he was able to see happened to all arise from transitions into the same final energy level.

    a. Examine the results of your prelab calculations. Describe how the lines for the transitions that end in $n_f = 1$ (there are five of these) would need to be graphed to determine the value of $R_E$. Is the slope the same or different from the value determined in our experiment? What about the y-intercept? How would it compare? Examine the equation we are graphing, and complete part (c) below. Explain why the answers you just gave make perfect sense.

    b. Discuss what would happen to a graph of the type you prepared today if half of the lines observed ended in $n_f = 1$ and half ended in $n_f = 2$. You may again want to look at the graph of your data and the prelab data.

    c. Add lines to your graph for the results of your prelab calculations for the transitions that end in $n_f = 1$ and also those that end in $n_f = 3$ (use the correct value for $n_f$).