

CHEM 260

Assignment 7

Due Monday 3rd March 2003

*If you wish you may submit your answers to this assignment in the form of an Excel file by E-mail attachment or on floppy disk (IBM format only). Printouts are also acceptable. You don't **have** to use Excel for this assignment, but if you try it without any computer aid... Good Luck!*

Imagine you have been sent back in time about 100 years to help the early spectroscopists interpret the emission spectrum of atomic hydrogen. The data[#] is driving Ritz crackers! He can see from his photographic plate that there are definite patterns to what look like overlapping series. The problem is to find the formula that fits the frequencies. You, of course, remember the general expression

$$\tilde{\nu} = \frac{1}{\lambda} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad n_2 > n_1 \quad R \text{ is a constant}$$

and luckily you took your laptop with you in the time machine. Help Ritz by working through the following procedure.

25. You notice that the wavenumbers above 82000 are well separated from the rest. Suppose they form a series with fixed n_1 . Then a plot of ν against $1/n_2^2$ should be a straight line. Try it (you need to assume a starting value for $n_2 = n_1 + 1$). Make sure you choose sensible axis limits so that the data is not squished up at the top of the plot. What are the values of the slope and intercept? The relationship between these two numbers should confirm the value of n_1 .
26. Where does the next series start? Looking at the intensities should help you choose. n_1 should be larger by 1 than for the first series. Remember also that $n_2 > n_1$. Once again the values of the slope and intercept of a straight line should confirm the correct assignment of quantum numbers.
27. Continue the procedure for higher series. Beware of possible overlap between series. You will get a non-linear plot if the assignments are wrong.
28. When you get to the last few spectral lines it is easier to guess the quantum numbers and observe the effect in the spreadsheet. Report the complete assignment (i.e. fill in the table overleaf).
29. The plots for the different spectral series should all be parallel, i.e. have the same slope (R_H). What do the intercepts represent? Convert them to energy units and report them in eV.

[#] See back of page, or better, download the file from the web site and import it into Excel.

Emission spectrum of atomic Hydrogen

Intensity	$(1/\lambda) / \text{cm}^{-1}$	n_1	n_2
15	107965		
20	107440		
30	106632		
50	105292		
100	102824		
300	97492		
1000	82259		
5	26073		
6	25713		
8	25188		
15	24380		
30	23039		
80	20571		
180	15237		
5	10476		
7	9951		
12	9142		
20	7801		
2	5502		
40	5333		
3	5143		
5	4618		
8	3809		
15	2468		
4	2149		
6	1341		
3	809		