PHYS 1402
General Physics II
EXPERIMENT 11

LINE SPECTRA

I. OBJECTIVE

The objective of this experiment is to observe the line spectra of three gases. For hydrogen, the wavelengths of the photons involved in the transitions will be calculated and compared with the wavelengths of the observed emission lines. For two other gases, the wavelengths of the emission lines will be observed and compared with those given in the spectrum chart hanging on the wall of the lab.

II. APPARATUS

Spectrometer, discharge tubes for three gases and their power supply.

III. EXPERIMENTAL PROCEDURE

1. Insert the hydrogen gas discharge tube in the power supply, turn the power supply on and set the spectrometer as close to the tube as possible with the slit lined up with the tube.

2. Observe the line spectrum of hydrogen. Record the observed wavelengths in the data table.

3. Repeat steps (1) and (2) for two other gases.

IV. ANALYSIS

1. For each case, calculate the frequency of the photon associated with each line from the equation $f = c/\lambda$

2. For each case, calculate the energy difference between the high and low energy levels involved in the transition from the equation

$$\Delta E = E_{n'} - E_n = hf. \tag{1}$$

3. For hydrogen, use the energy level diagram in the textbook and identify the two levels associated with each emission line. Now identify the series each line belongs to: Lyman, Balmer or Paschen.

4. For hydrogen, look up the wavelengths of the emission lines given in your book and calculate the percent difference between these and the ones you observed.

5. For the two other two gases you observed, look up the wavelengths of the emission lines given in Spectrum Chart hanging on the wall of the lab and record them in your data table.

6. Calculate the percent difference between the observed wavelengths and the ones given in the chart.

7. For hydrogen, use the observed wavelengths and plot $\frac{1}{\lambda}$ on the vertical axis and $\frac{1}{n^2}$ on the horizontal axis. Here n is the quantum number of the higher level associated with particular wavelngth λ.

8. Draw the best straight line fit for the data and calculate its slope. This slope is the negative of the Rydberg constant $R = 1.097 \times 10^7\,\mathrm{m}^{-1}$. In 1885, J. J. Balmer showed that the four visible lines in the hydrogen spectrum fit the following formula

$$\frac{1}{\lambda} = R(\frac{1}{2^2} - \frac{1}{n^2}) \tag{2}$$

where $n = 3, 4, 5, 6$ and R is the Rydberg constant.

9. Write a conclusion summarizing your results. In your conclusion, comment on the accuracy of this experiment. What are the two most important sources of error?

Experiment (11) Data Table				
Gas: Hydrogen				
Observed Wavelength and Color λ (nm)	Wavelength and Color (Chart or Book) λ (nm)	Frequency $f = c/\lambda$ (Hz)	Change in Energy $\Delta E = hf$ (ev)	(Higher Level→ Lower Level) $(n' \rightarrow n)$ Which Series?

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Observed Wavelength and Color λ (nm)	Wavelength and Color (Chart or Book) λ (nm)	Frequency $f = c/\lambda$ (Hz)	Change in Energy $\Delta E = hf$ (ev)	(Higher Level→ Lower Level) $(n' \rightarrow n)$ Which Series?

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