PHYS 3650L - Modern Physics Laboratory

Laboratory Advanced Sheet

The Emission Spectrum of Hydrogen

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1. Objectives. The objectives of this laboratory are

a. to study the emission spectrum of hydrogen, and

b. to determine Rydberg constant.

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2. Theory.

a. If a large voltage is applied across a sealed tube filled with a low-pressure gas, the gas will emit electromagnetic radiation characteristic to the individual gas atoms. The resulting emission spectrum consists of a collection of well-defined lines which is unique for a particular atom. It was discovered that the lines in the emission spectrum of hydrogen (which was intensively studied during the nineteenth century) can be grouped into series, labeled n' = 1, 2, 3, etc, with the wavelength of a particular line in a series given by the following simple expression:

$$\frac{1}{\lambda} = R\left(\frac{1}{n'^2} - \frac{1}{n^2}\right) \qquad \textbf{(1)}$$

where

n' = 1, 2, 3,.....,

$n = n' + 1, n'+2, n'+3,....$, and

$R = 1.097 \times 10^7\ m^{-1}$ is the Rydberg constant.

b. Balmer series, a collection of lines in the visible portion of the hydrogen spectrum, is given by n' = 2:

$$\frac{1}{\lambda} = R(\frac{1}{4} - \frac{1}{n^2}) \qquad \textbf{(2)}$$

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3. Apparatus and experimental procedures.

a. Equipment.

1) Spectrometer.

2) Diffraction grating.

3) Hydrogen gas tube.

b. Experimental setup. To be provided by the student.

c. Capabilities. To be provided by the student.

d. Procedures. Detailed instructions are provided in paragraph 4 below.

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4. Requirements.

a. In the laboratory.

1) Your instructor will introduce you to the equipment to be used in the experiment.

2) Measurements to determine the angles of diffraction will be made for three different lines in the spectrum of hydrogen.

3) Your instructor will discuss methods to be used to prepare your data for plotting using the Microsoft Excel™ spreadsheet program.

b. After the laboratory. The items listed below will be turned in at the beginning of the next laboratory period. A complete laboratory report is **not** required for this experiment.

Para 3. Apparatus and experimental procedures.

1) Provide a figure of the experimental apparatus (para 3b).

2) Provide descriptions of the capabilities of equipment used in the experiment (para 3c).

Para 4. Data. Data tables are included at Annex A for recording measurements taken in the laboratory. A copy of these tables must be included with the lab report. Provide the items listed below in your report in the form a Microsoft Excel™ spreadsheet showing data, calculations and graphs. The spreadsheet will include:

1) A table with columns for line color, measured angle of diffraction to the right, angle of diffraction to the left, mean angle of refraction, calculated wavelength, inverse wavelength, number n responsible, and 1/4 $-1/n^2$.

2) A graph of the inverse wavelength vs. 1/4 $-1/n^2$.

3) Regression line for the inverse wavelength vs. 1/4 $-1/n^2$.

4) Experimental value of the Rydberg constant.

5) Calculation of the percent discrepancies in the Rydberg constant.

Para 5. Results and Conclusions.

a. Results.

1) A statement regarding the agreement or disagreement between the predicted and measured dependence of wavelength on *n*.

2) A statement of the measured value for the Rydberg constant.

2) A statement of the percent discrepancy between measured and accepted values of Rydberg constant.

b. Conclusions.

1) Assess the accuracy of your experiment.

2) Describe the sources of error in the experiment.

Annex A
Data

1. Diffraction grating constant.

a = _____m

2. Angle of diffraction.

Line	Diffraction Angle (degrees/minutes)			
	Right		Left	
Spectral order, m	1	2	1	2
Violet				
Bluegreen				
Red				