PHYL202

Applied Exam-2

Duration: 40 minutes

Total: 6 points

Name & Surname:

1 **Student ID:**

Lab section:

Table #:

Date:

Signature of the student

As the instructor of this Lab Section I confirm that the student has participated in and completed the applied exam on time.

Stamp of the PHYS Labs and signature of the instructor

This page serves as proof of the fact that the student participated in and completed the applied exam, only if it is submitted in time and accepted by the Lab instructor. The student and the instructor shall sign it along with the stamp of the Physics Laboratories.

Complete this examination YOURSELF! Be careful about units, significant figures. You shall show all your formulae & calculations explicitly and express your final answers clearly.

1. Read all instructions carefully before beginning the exam.

2. Follow the procedure step by step as outlined in the exam document.

3. Record your measurements in the provided data table.

4. Ensure all calculations are shown clearly in the appropriate section.

5. Use only a scientific calculator. No smartphones or other electronic devices are

allowed.

6. Write all numerical values with correct significant figures and units.

The Hydrogen Spectrum Experiment

Objective

To study the visible spectral lines of hydrogen, calculate the Rydberg constant, and compare it with the theoretical value.

Theory

The wavelengths of the spectral lines for the Balmer series of hydrogen are given by the Rydberg formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right), \quad n > 2$$

where:

- λ is the wavelength of the spectral line.
- R is the Rydberg constant ($R = 1.097 \times 10^7$ m^{-1}).
- n is the principal quantum number of the upper energy level.

The experiment involves measuring the wavelengths of the visible hydrogen lines, calculating the Rydberg constant, and comparing it to the theoretical value.

Apparatus

- Spectrometer
- Hydrogen discharge tube
- Power supply for the discharge tube
- Diffraction grating
- Ruler or measuring scale

Procedure

1. Set up the spectrometer and align it properly with the hydrogen discharge tube and the diffraction grating.
2. Switch on the power supply to the hydrogen discharge tube and observe the visible spectral lines through the spectrometer.
3. Measure the diffraction angles θ for the first-order spectral lines corresponding to the red, blue-green, and violet lines.
4. Use the diffraction formula $d\sin\theta = m\lambda$, where $m = 1$, to calculate the wavelengths λ of the observed lines.
5. Calculate the Rydberg constant R using the measured wavelengths and the Rydberg formula.

6. Calculate the average of the calculated Rydberg constants.
7. Compare the average Rydberg constant to the theoretical value and calculate the percentage error.

Table 1: Angle Measurements

Color of Line	**Angle from Left** (θ_L)	**Angle from Right** (θ_R)	**Average Angle** (θ_{avg})
Red			
Blue-Green			
Violet			

Table 2: Initial and Final States for Observed Lines

Color of Line	**Initial State** (n_i)	**Final State** (n_f)
Red	3	2
Blue-Green	4	2
Violet	5	2

Table 3: Wavelengths and Rydberg Constant

Color of Line	**Measured Wavelength (nm)**	**Calculated Rydberg Constant(m^{-1})**
Red		
Blue-Green		
Violet		

Calculations

- Use the diffraction formula to calculate the wavelengths λ of the spectral lines from the measured diffraction angles, assuming that the diffraction grating has 600 lines per millimeter as stated by the manufacturer. Record the results in the provided table(Table 3) with four significant figures and in the given units.

- Use the Rydberg formula to calculate the Rydberg constant R for each spectral line. Record the results in the provided table(Table 3) with four significant figures and in the given units.

- Calculate the average value of the Rydberg constants obtained from your measurements and write your answer in the box below.

  Answer:

- Calculate the percentage error for the average Rydberg constant using the following formula, where the theoretical value R_{tv} is $1.097 \times 10^7\,\text{m}^{-1}$:

$$\text{Percentage Error} = \frac{|\text{Average Calculated } R - R_{\text{tv}}|}{R_{\text{tv}}} \times 100$$

  Write your answer in the box provided below.

  Answer: