Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab* complete this page YOURSELF! Hand it in *in the first 5 min*. of the session PERSONALLY!**

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read the relevant presentation on PHYS LAB Website.

In this experiment spectrum of an unknown gas is going to be studied by using a spectrometer and a diffraction grating.

Q1. What is diffraction grating?

Q2. What is the maximum number of orders that can be observed with the grating used in the experiment? **Justify your answer, show calculations if needed or no credits!**

Q3. Why is it preferable to use a grating with a small d for accurate spectral analysis? **Justify your answer or no credits!**

(3rd and 4th Questions are on the next page!)

Q4. Should the angular separation between two lines be the same for each order? Why? **Justify your answer or no credits!**

Q5. Prove that the angular dispersion of a grating can be written as: $D = \tan\theta/\lambda$. Hint: Use the grating equation. **Show your calculations below explicitly or no credits!**

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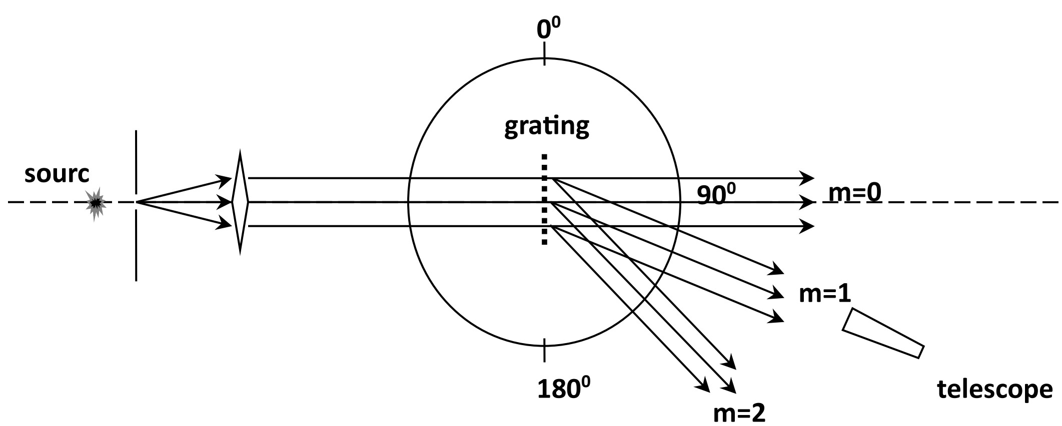
***Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest!* Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To use a diffraction grating to determine the wavelengths corresponding to various spectral lines.

THEORY : Light shining perpendicularly on a diffraction grating produces an interference pattern on a screen or on your retina if you are viewing from behind the grating. Positions of the maxima in the resulting interference pattern are given by the grating equation:

$$m\lambda = d\sin\theta$$

where *m* is the order of the spectrum, λ is the wavelength of the incident light, *d* is the distance between the lines on the grating, and θ is the angle at which the maximum intensity occurs. Angles are measured with respect to the incident light direction.



If the incident light has components with many wavelengths then you will see these different wavelengths separated from each other. The resolving power of a grating is given in terms of its ability to separate two wavelengths which differ by $\Delta\lambda$:

$$R = \frac{\lambda}{\Delta\lambda}$$

where λ is the average of these two wavelength values. Resolving power is also related to the number of lines (*N*) on the grating through

$$R = Nm$$

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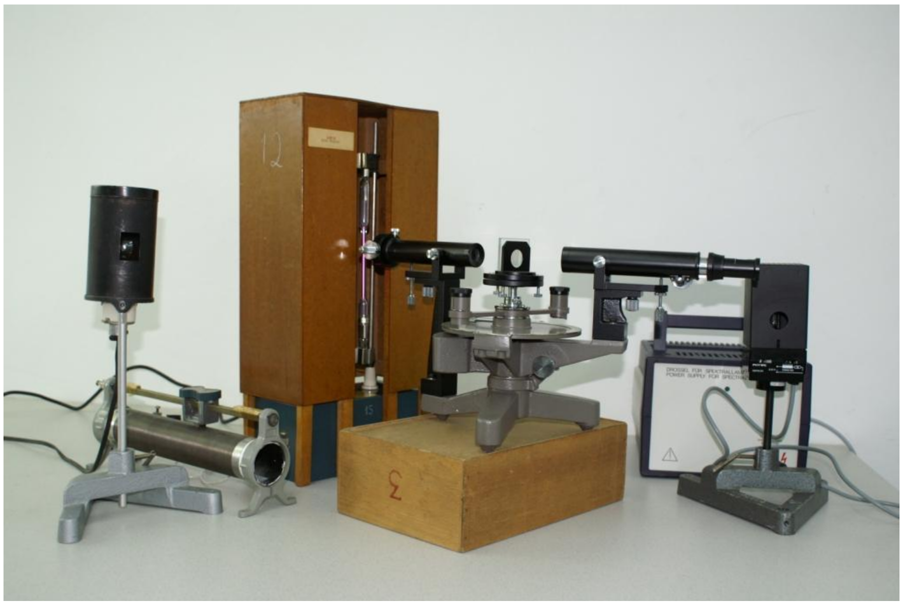
The angular dispersion *D* of a grating is defined as a measure of the angular separation produced between two monochromatic light waves whose wavelengths are close to each other.

$$D = d\Theta / d\lambda = \tan\Theta / \lambda$$

where Θ is the average of the angles corresponding to the two lines that are close to each other in wavelength and λ is the average of these wavelength.

APPARATUS : Spectrometer, sodium lamp with its power supply, discharge tube with its power supply



PROCEDURE :

1. Adjust the collimator for parallel light, focus the objective on a distant object, and adjust the cross-hair so that it is visible on the image of the distant object and fix the telescope so that the zero position of the body becomes the zero position of the telescope.
2. Release the telescope to move freely. Then mount the diffraction grating carefully on the spectrometer.
3. Using the sodium lamp as the light source, determine the angular position of the first order maximum for the yellow line on either side of the center. C
4. Calculate the diffraction separation d.
5. Using the discharge tube containing unknown gas as the light source, determine the angles for all visible lines.
6. Calculate the wavelengths of those spectrum lines. Identify the gas in the discharge tube by making use of the table in Appendix A.
7. Selecting two barely separated lines in your discharge tube spectrum, determine the angular dispersion of your grating.
8. Use the white light source to determine the wavelength limits for visible light.

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PART I: DETERMINATION OF DIFFRACTION GRATING CONSTANT, d

Wavelength of

sodium doublet λ = 5890 Å and 5895 Å average 5893 Å

Order of the spectrum m = ...

Angle of spectrum line θ_{left} = ...

(Uncalibrated)

Angle of spectrum line θ_{right} = ...

(Uncalibrated)

Average angle θ_{ave} = ...

Diffraction Separation d = ...

....

Tehoretical value of d

Diffraction Separation d_{TV} = ...

% Error for d = ...

4

PART II: UNKNOWN DISCHARGE TUBE

Discharge Tube Number : . . . .

Color	θ_{left} (uncalibrated)	θ_{right} (uncalibrated)	$\theta_{average}$	λ ( )

PART III: DISPERSION MEASUREMENT

COLOUR	θ_1 (uncalibrated)	θ_2 (uncalibrated)	θ_{ave}	λ_{ave} ( )

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PART IV: WHITE LIGHT SPECTRUM

COLOUR	θ_{left} *(uncalibrated)*	θ_{right} *(uncalibrated)*	$\theta_{average}$	λ ( )
Red End				
Violet End				

RESULTS:

Gas in the Discharge Tube is (*check the appropriate box*) :

☐ **Argon** ☐ **Xenon** ☐ **Hydrogen**

☐ **Helium** ☐ **Mercury** ☐ **Neon**

Dispersion of the spectrometer:

$D = \tan\Theta / \lambda$ = ...

. . . .

Limits of the visible range :

. . . . < λ ( ) < . . . .

Consult to the resources for this experiment from PHYS LAB Website:

PHYL202 Intro

Presentation #6

PHYL202 Lab Book

Spring 2024