Physical optics

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete all the identification fields below or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Physical optics

Name:

Student number:

Lab group number:

Course code: PHY

Demonstrator:

Date:

Partner's name:

Single-slit vs. double-slit

[2] Describe how the pattern is changing as you increase the slit width for a single-slit. If possible, be **quantitative** in your description of what is changing.

[2] Describe how the pattern is changing as you increase the distance between two slits for a double-slit. If possible, be **quantitative** in your description of what is changing.

[2] Sketch the two interference patterns for a single-slit and double-slit side-by-side roughly to scale. Describe how the pattern is changing as you are adding a slit of the same width.

[2] Count how many bright fringes are in the center peak of the diffraction envelope for the double slit pattern? How many did you expect? (Hint: Use the equation for the width of a single slit peak and compare it with the equation for the separation of double slit peaks). **(This is a bonus question! Up to 2 marks.)**

Diffraction grating

[2] Compare the two patterns when you switch from the 600 lines/mm to the 300 lines/mm grating. Explain how the pattern is changing. Repeat for the 100 lines/mm grating.

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[2] Measure the length y for the $m = 1$ bright fringes using the 600 lines/mm grating. Measure the distance D between the diffraction grating and the screen. **Estimate** the uncertainties and provide the units.

$D =$ ____________________ $\pm$ ____________________

$y(m = 1, \text{right side}) =$ ____________________ $\pm$ ____________________

$y(m = 1, \text{left side}) =$ ____________________ $\pm$ ____________________

[3] Since you know the distance between the lines of the grating (600 lines/mm), and since you also know that $d \sin\theta = m\lambda$, find λ, the wavelength of the laser. Note: $\tan\theta = y/D$. (no uncertainty calculation needed).

$\lambda_{\text{laser}} =$ ____________________

The spectrum of white light

[2] You should be able to observe the first order of diffraction of the white light. What do you observe? What is the relationship between the diffraction angles and the wavelengths? Note that the typical visible spectrum of wavelengths detected by the human eye goes from 400 nm to 700 nm (from violet to red).

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[2] In the previous experiment, you used a prism to disperse white light in various wavelengths. In this experiment you learned that a diffraction grating can also be used to disperse white light as well. Can you explain the difference between the two dispersion mechanisms?

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The spectrum of the mercury lamp

[3] Note the distance D between the grating and the screen. Note the length y for the first yellow, green, and blue fringes. **Estimate** the uncertainties and provide the units.

$D =$ ____________________ $\pm$ ____________________

$y_{\text{yellow}}(m = 1, \text{right side}) =$ ____________________ $\pm$ ____________________

$y_{\text{yellow}}(m = 1, \text{left side}) =$ ____________________ $\pm$ ____________________

$y_{\text{green}}(m = 1, \text{right side}) =$ ____________________ $\pm$ ____________________

$y_{\text{green}}(m = 1, \text{left side}) =$ ____________________ $\pm$ ____________________

$y_{\text{blue}}(m = 1, \text{right side}) =$ ____________________ $\pm$ ____________________

$y_{\text{blue}}(m = 1, \text{left side}) =$ ____________________ $\pm$ ____________________

[4] Since you know the distance between the lines of the grating (600 lines/mm), and since you also know that $d \sin\theta = m\lambda$, find λ, the wavelengths emitted by the mercury lamp. (no uncertainty calculation needed).

$\lambda_{\text{yellow}} =$ ______________	$\lambda_{\text{green}} =$ ______________	$\lambda_{\text{blue}} =$ ______________

[1] What is the difference between the mercury lamp spectrum and the spectrum of white light you observed?

[1] Why can't you see the spectrum of the white lamp or the mercury lamp at $m = 0$?

Diffraction around an obstacle

[2] Describe and explain your observations for the “diffraction around an obstacle” setup.

Polarization

[1] Place one polarizing filter on top of a second so you have to look through both of them. Rotate one of the filters while looking through both polarizers. What do you notice?

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[4] Prepare Graph 1. Submit it online before the end of the lab session.

[1] What are the values of m (slope) and b (Y-intercept) in Graph 1? Provide the units.

m = __________________ ± __________________

b = __________________ ± __________________

[2] What is the physical meaning of the slope and the Y-intercept? What values did you expect to get?

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[2] Are your results consistent with Malus's law?

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Total : _______ / 38 (for the report and graph)

Up to 40 marks with bonus.