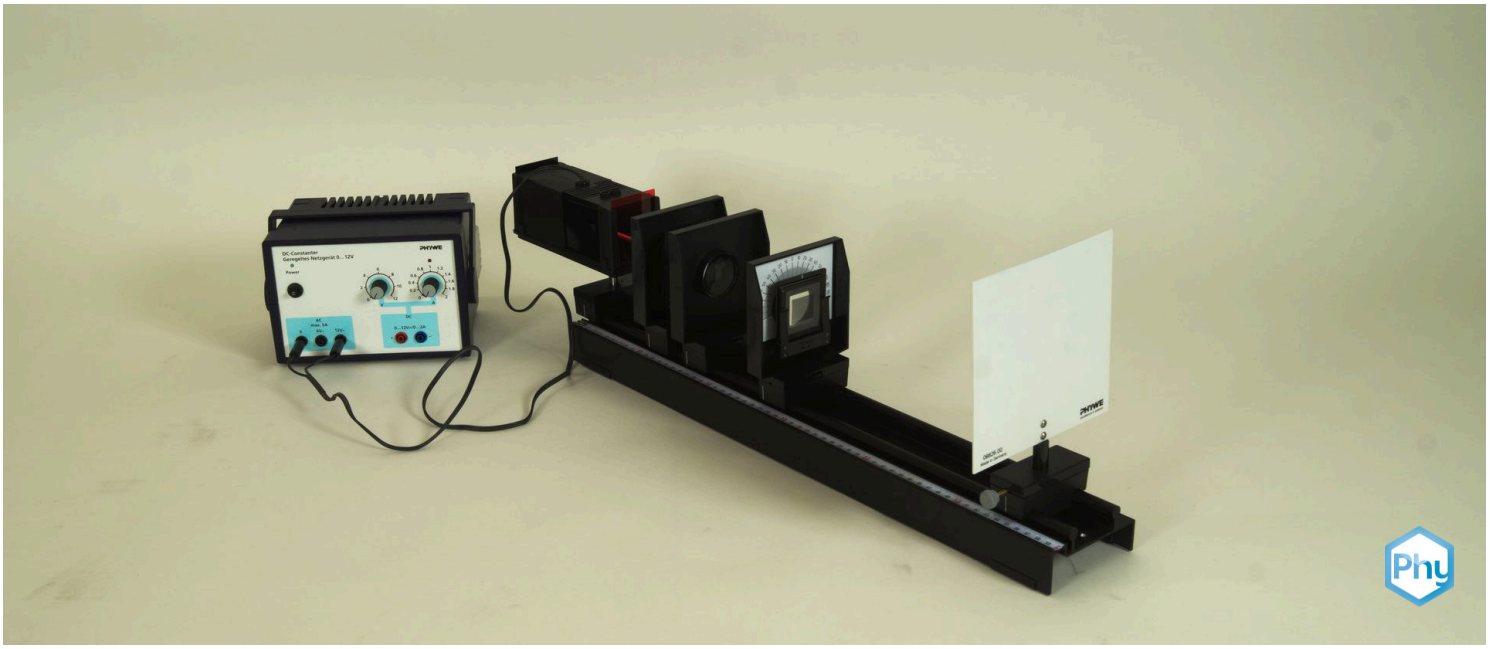
Determination of the wavelength by grid diffraction



Physics > Light & Optics > Diffraction & interference

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/62e4eb0a932bae00030ac51a

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Teacher information

Application

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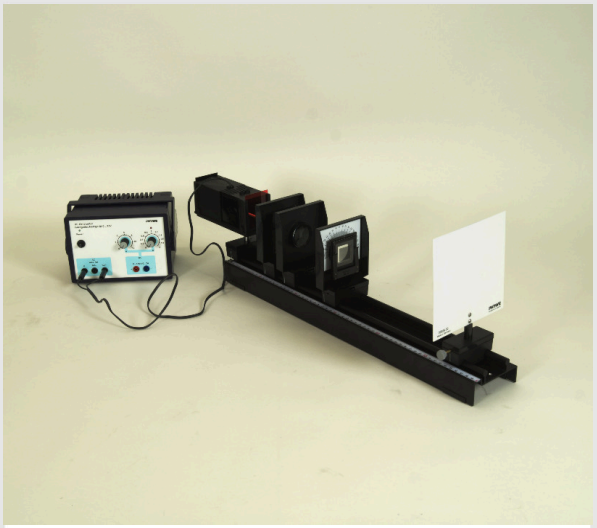

Experimental setup

An optical grating is a periodic structure to diffract incident light. In the process, the spectrum of the incident light becomes visible. Gratings can be used for spectral analysis or also monochromatisation.

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Other teacher information (1/4)

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Principle

The optical grating deflects the incident light at each slit, causing interference behind the grating. A symmetrical interference pattern is created, whereby the light is split into its spectrum.

Learning objective

The students should observe the diffraction effect on the grating and use it to calculate the wavelength of the light.

Other teacher information (2/4)

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Task

The students are asked to create diffraction spectra using an optical grating and to determine the wavelength of red and green light.

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Other teacher information (3/4)

- The experiment on diffraction at the optical grating not only provides convincing proof of the interference capability of (visible) light and thus of its wave character, but it is also well suited for determining the wavelength for selected colours of the spectrum. In addition, it can serve as a strong motivator, because many students will be impressed that such small physical quantities can be determined quite precisely here with simple means.

Other teacher information (4/4)

Notes on set-up and procedure

- The experiment should be carried out in a very darkened physics room. Then second-order diffraction spectra can still be clearly detected.
- The determination of the measured values when determining the wavelengths for selected colours can also be done without using the filters. This would have the advantage that the middle bright strip on the screen would not also appear coloured.
- It should be left to the students to decide whether they want to be involved in the measurement of $2e$ choose the distance between the centres of the two colour stripes or, for example, the distance between the outer edges of these stripes (slit images): The result is only a matter of adjusting the size λ to obtain a good approximation of the size of light wavelengths.

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Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student information

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Motivation

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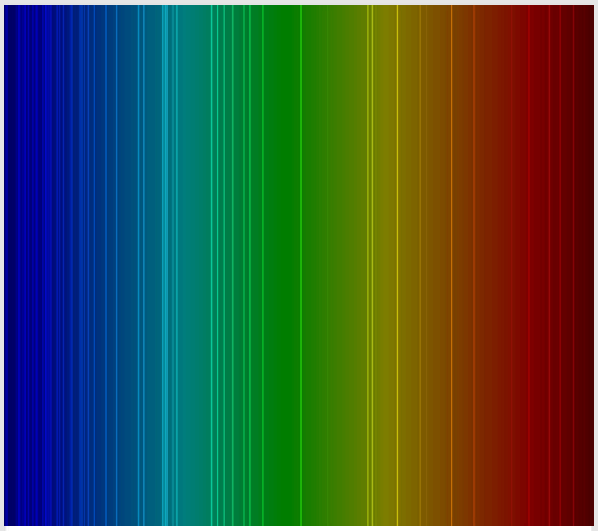

Spectral lines of white light

An optical grating is a periodic structure to diffract incident light. In the process, the spectrum of the incident light becomes visible. Gratings can be used for spectral analysis of materials or also for monochromatisation (isolation of a specific wavelength).

How does an optical grating work and how can it be used to determine the wavelength of light?

Tasks

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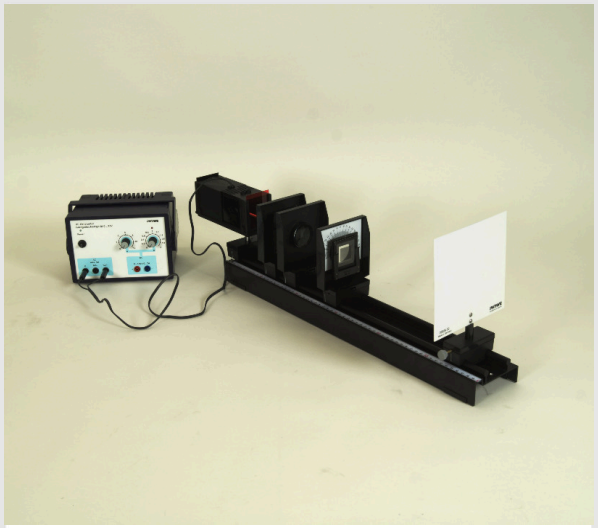

Experimental setup

Create diffraction spectra using an optical grating and determine the wavelength of red and green light.

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Equipment

Position	Material	Item No.	Quantity
1	Optical profile-bench for student experiments, l = 600 mm	08376-00	1
2	Light box, halogen 12V/20 W	09801-00	1
3	Bottom with stem for light box	09802-20	1
4	Colour filter set, additive (red, blue, green)	09807-00	1
5	Diaphragm with slit	09816-02	1
6	Lens on slide mount, f=+50mm	09820-01	1
7	Lens on slide mount, f=+100mm	09820-02	1
8	Slide mount for optical bench	09822-00	1
9	Mount with scale on slide mount	09823-00	1
10	Screen, white, 150x150 mm	09826-00	1
11	Diaphragm holder, attachable	11604-09	2
12	Grating, 80 lines/mm	09827-00	1
13	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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Set-up (1/2)

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- Assemble the optical bench from the two tripod rods and the variable tripod foot.

Set-up (2/2)

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- Place the base with the stem under the light box and clamp it into the left part of the tripod base so that the lens side faces away from the optical bench.
- Slide an opaque screen in front of the lens of the luminaire.

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Procedure (1/5)

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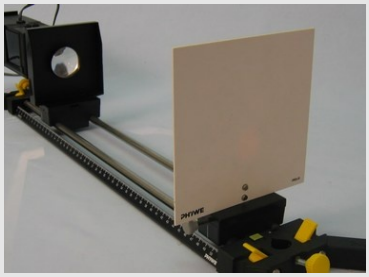

- Connect the lamp to the power supply unit (12 V~).
- Place the screen on the right end of the optical bench and the $f = +100\,\mathrm{mm}$ lens near the lamp and move it until the circular light spot on the shade has a diameter that is about the same as the diameter of the lens.

Procedure (2/5)

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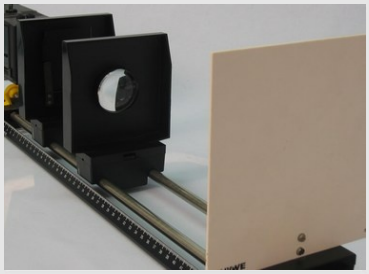

- Slide the aperture with the slit into an aperture holder and place it on the rim of the lens.
- Use the $f = +50\,\mathrm{mm}$ lens and move them until a sharp image of the slit appears on the screen.

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Procedure (3/5)

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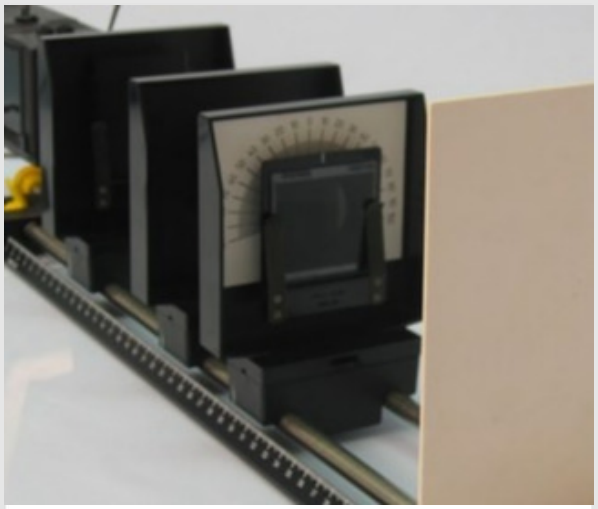

Experimental setup

- Set the frame with scale to the right of the lens (with $f = +50\,\mathrm{mm}$), slide the grid into the second aperture holder and place it on the socket.
- On the screen you get the diffraction spectra (coloured images of the slit).
- Move the grid towards the screen and back and observe the changes that occur on the screen. Write down your observations to answer task 1 in the report .

Procedure (4/5)

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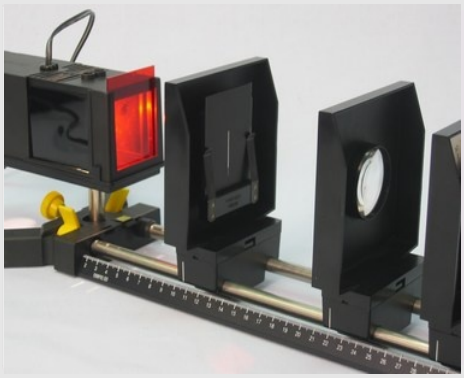
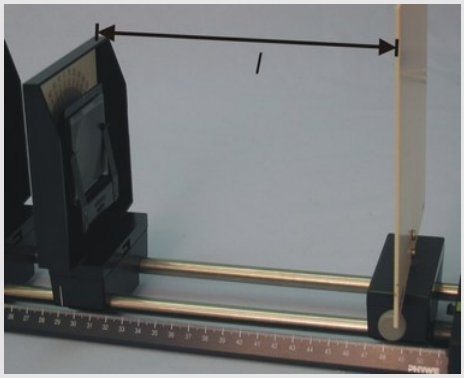
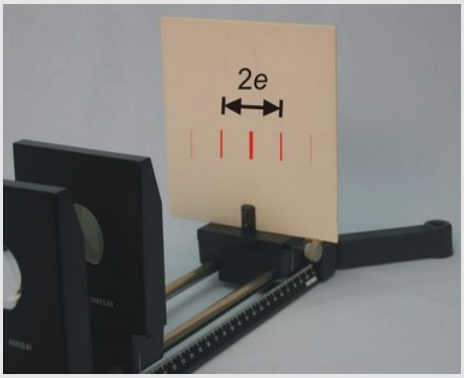
- Insert the red filter into the aperture shaft of the light and measure the following sizes: l = Distance of the grid from the screen, $2e$ = Distance of the two red stripes from each other, which lie to the left and right of the centre. Enter the measured values in Table 1.







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Procedure (5/5)

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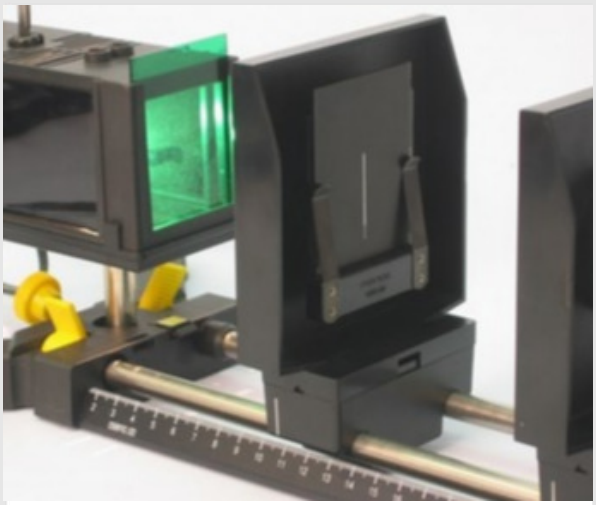

Green filter in the aperture shaft

- Replace the red filter with the green filter and also determine the value $2e$ for green light. Enter the measured value in Table 1.

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Report

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Table 1

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Enter your measured values in the table and calculate the wavelength λ of red and green light according to the equation $\lambda = e \cdot d/l$ (d = Lattice constant = 1/80 mm = 0.0125 mm).

Colour of the light	l [mm]	$2e$ [mm]	λ [mm]
Red			
Green			

Task 1

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What do you observe in the spectrum when you move the grid?

- ☐ At a rotation angle of 90°, the light spot is dark.
- ☐ The light spot changes its shape.
- ☐ The observations are the same as before.

Check

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Task 2

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Light of which colour is diffracted most or least by the grating?

- ☐ red light the strongest.
- ☐ yellow light is weakest.
- ☐ violet light the strongest.
- ☐ violet light is weakest.

Check

Slide	Score / Total
Slide 21: Shifting the grid	0/2
Slide 22: Effect of the grid	0/2

Total 0 / 4

Solutions | Repeat | Export text

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