Spectra resolving power of a grating

Task and equipment

Information for teachers

Additional Information

In order to assess the spectral resolving power of an optical grating we utilize the quotient λ/Δλ. This quotient can only be determined accurately if we can create a line spectrum containing lines at suitable distance Δλ apart.
However, even with fairly simple means it is possible to arrive a statement on the spectral resolving power of a grating which are sufficiently informative for school pupils.

Suggestions for Set-up and Performance

The experiment can be carried out in a semi-darkened room. The setup is not difficult but the students will possibly need some guidance from the teacher when making their observations. For instance, in Experiment 2 they should make the observation that higher-order spectra overlap and that, when using the red filter, the width of the higher-order diffraction peaks tends to be judged too low as a result of their decreased intensity.

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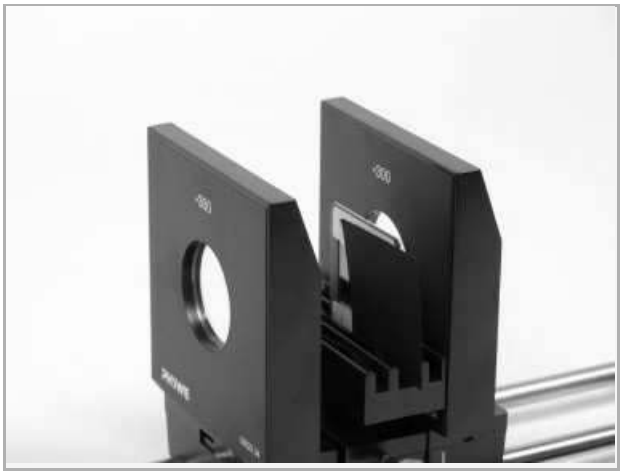
Task

What are the determing factors for the resolving power of a grating?

Investigate to what extent the resolving power of a grating depends

1. on the number of active grating slits and
2. on the order of the diffraction spectrum.



Student's Sheet

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Equipment

Position No.	Material	Order No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Bottom with stem for light box	09802-10	1
3	Support base, variable	02001-00	1
4	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
5	Meter scale for optical bench	09800-00	1
6	Colour filter set, additive (red, blue, green)	09807-00	1
7	Lens on slide mount, f=+50mm	09820-01	1
8	Lens on slide mount, f=+300mm	09820-04	2
9	Slide mount for optical bench	09822-00	2
10	Mount with scale on slide mount	09823-00	1
11	Plate mount f.3 objects	09830-00	2
12	Measuring magnifier	09831-00	1
13	Diaphragm, 4 multiple slits	08526-00	1
14	Diffraction grating, 4 lines/mm	08532-00	1
15	Slit, adjustable.up to 1 mm	11604-07	1
16	Diaphragm holder, attachable	11604-09	1
17	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
18	Cardboards 200x300mm,black,10 pcs	06306-01	(1)
Additional material			
	Scissors		1

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Set-up and procedure

Experiment 1

- Set up the optic bench with the two support rods and the support base and place the scale in position (Fig. 1 and Fig. 2).

Fig. 1

Fig. 2

- Assemble the light box according to Figures 3 and 4 and clamp it into the left part of the support base with the lens end pointing away from the optic bench (Fig. 5). Insert a light-tight diaphragm into the well in front of the lens (Fig. 6).

Fig. 3

Fig. 4

Fig. 5

Fig. 6

- Position the lens f = +50 mm at 5.5 cm on the optic bench (Fig. 7).

Fig. 7

- Place the mount with the scale at 10 cm and attach the diaphragm holder with the adjustable slit to the mount (Fig. 8).

Fig. 8

- Position one lens with f = +300 mm at 30 cm, the second at 37 cm and a plate mount at 34.5 cm (Fig. 9).

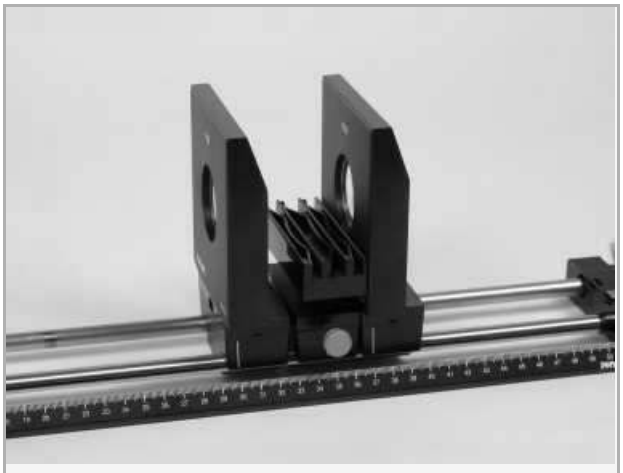

Fig. 9

- Set up a slide mount with a plate mount holding the observation lens approx. 50 cm to the right of the optic bench.
- Insert the red filter into the light well (Fig. 10).

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Fig. 10

- Connect the light to the power supply (12 V~) and swith on the power supply (Fig. 11).

Fig. 11

- Move the observation lens along the optical axis to focus the slit clearly in the observation plane.
- Adjust the width of the slit until the slit image is approx. 0.2 mm wide.
- Attach a diaphragm with multiple slits to the plate holder positioned at 34.5 cm (Fig. 12) and move the double slit into the optical axis first; cover the other multiple slits with blanks of black card (approx. 50 x 50 mm); describe the diffraction pattern in the report.

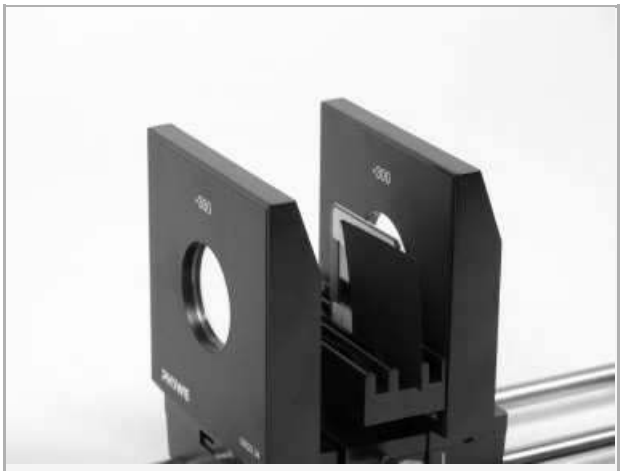

Fig. 12

- One after another move the triple, quadruple and quintuple slits, and finally the grating into the light path, observe and describe the different diffraction patterns, paying particular attention to the brightness and the width of the diffraction fringes. Note your observations in the report..
- Switch off the power supply.

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Experiment 2

- Remove the red filter and otherwise leave the setup as in experiment 1.
- Switch on the power supply and observe the diffraction pattern created by the grating with 4 lines/mm.
- Measure the width of the 1st, 2nd-, and 3rd-order diffraction spectra; enter values in table 1 in the report.
- Reinsert the red filter and measure the width of the interference peaks of the red light (this corresponds to the transmission range of the filter); enter the values in table 2 in the report.
- Switch off the power supply.

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Report: Spectra resolving power of a grating

Result – Observations 1

Describe the diffraction pattern:

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Result – Observations 2

Describe the brightness and the width of the diffraction fringes after another move the triple, quadruple and quintuple slits:

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Student's Sheet

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Result – Table 1

Record the result in the table:

Order of the spectrum	1.	2.	3.
Width in mm	1 ±0	1 ±0	1 ±0

Evaluation – Question 1

What conclusion do you draw from your observations regarding the resolving power of the grating?

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Evaluation – Question 2

What statement can be made on the basis of the measurements in table 1?

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