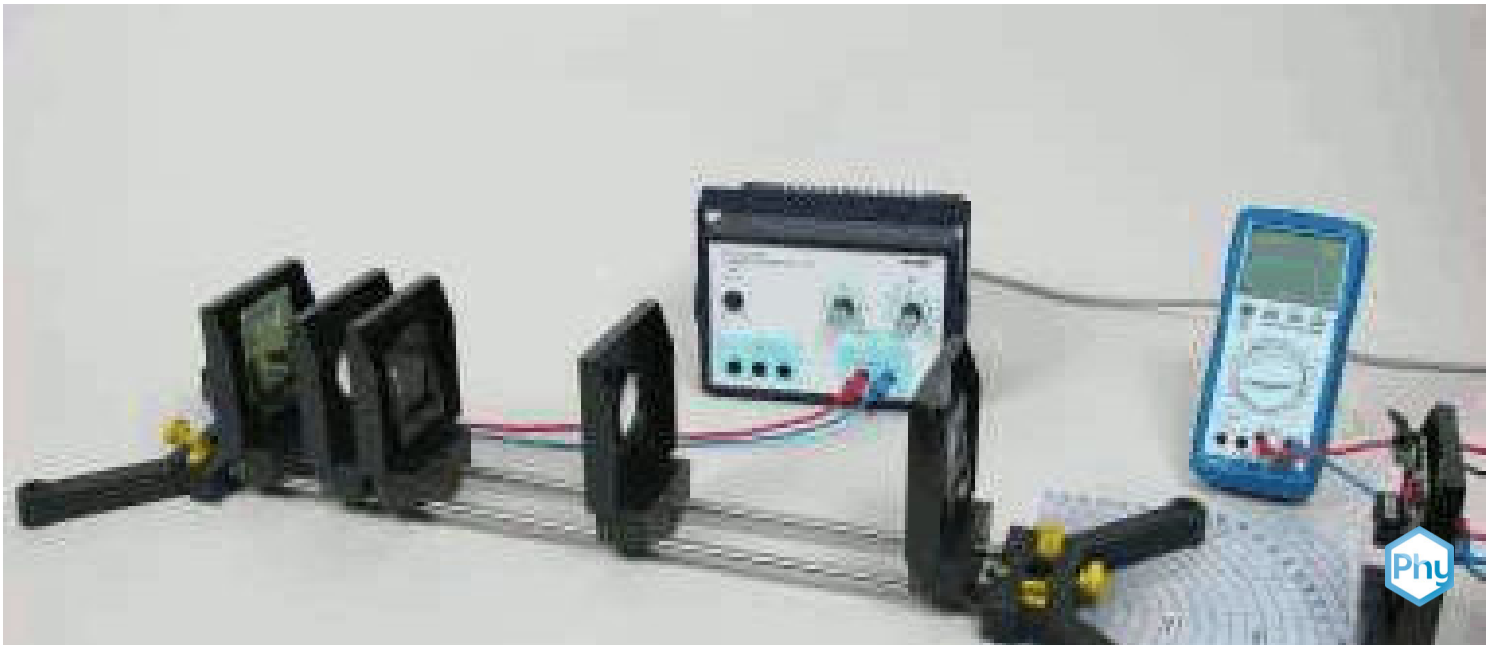
What does the spectrum of a light emitting diode (LED) look like?



Physics > Modern Physics > Quantum physics

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/5f50582137ffe20003f0ffe4

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Teacher information

Application

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Experiment set-up

What does the spectrum of a light emitting diode (LED) look like?

If we look at a white LED through a grid, we see color components over almost the full spectrum.

However, an objective determination of the intensities of the individual color components is not possible with the naked eye because our eye is not equally sensitive to all optical frequencies. Green light, for example, is perceived more intensely.

In this experiment you will learn how to measure a spectrum with the help of a photodiode.

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Teacher information (1/2)

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Learning objective

Special care must be taken to ensure that the test arrangement does not shift during the measurement, especially the sheet with the angle scale, otherwise there is no longer a reference point for comparing the measured curves. In addition, the test should only be carried out in a completely darkened room.

Notes

If the room is completely dark, it can be difficult to read the measured values at the individual points. It is easier to do this by placing the multimeter in the straight beam path where the light just falling through the grating can illuminate the display.

Teacher information (2/2)

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Alternative implementation

If the experiment is to be carried out as a demonstration experiment, it is recommended to stick the photodiode on the carriage of an xy recorder and thus to run the spectrum and plot the measured values immediately.

For this purpose, the spectrum is mapped so that it covers the entire area of the plotter. The angle dependence is neglected in the experimental setup. Spectral sensitivityk

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Other teacher information (1/3)

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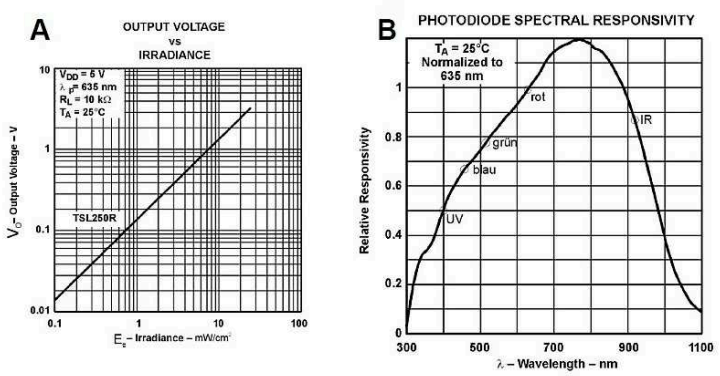

A - The measured voltage is well linear to the light intensity.

B - The photodiode has sufficient sensitivity for the spectral ranges of the LEDs.

Spectral sensitivity and properties of the photodiodes used:

The spectral sensitivity of the photodiode is not evenly distributed over the entire wavelength range of the detected light (B).

However, there is a linear relationship between light intensity and measured voltage (A) for the entire spectral range used.

Absolute brightness measurements or comparisons are possible.

Other teacher information (2/3)

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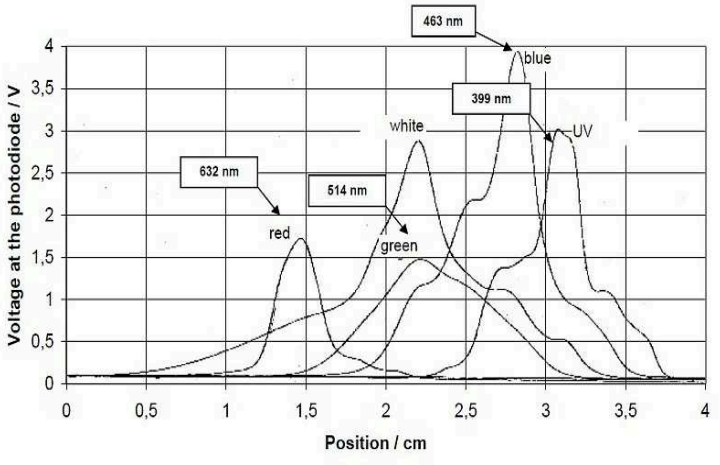

Measurement results and evaluation:

Since the results of the measurement change with the arrangement of the angle scale and the exact lens positions, a

spectrogram (figure) is used for evaluation.

These measured values were recorded with the described method using an xy-recorder to make the basic course clear.

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Other teacher information (3/3)

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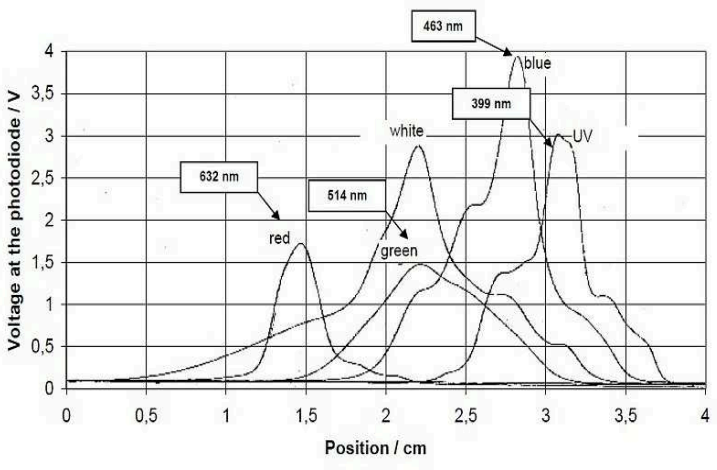

The figure shows the different courses of the spectra of the individual LEDs. Since the LEDs do not provide a homogeneously bright cone of light, the shape of the curves can sometimes be slightly different.

But the peaks are always clearly visible. Here you can also see that the white LED has a peak in the blue-green area. The highest peak is at about 500 nm.

The curve of the green LED is wider than e.g. the red one, which can also be seen when looking at the LED directly through the grid.

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

Motivation

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Experiment set-up

What does the spectrum of a light emitting diode (LED) look like?

If we look at a white LED through a grid, we see color components over almost the full spectrum.

However, an objective determination of the intensities of the individual color components is not possible with the naked eye because our eye is not equally sensitive to all optical frequencies. Green light, for example, is perceived more intensely.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
3	Slide mount without angle scale	09851-02	2
4	Mount with scale on slide mount	09823-00	2
5	Diaphragm holder, attachable	11604-09	4
6	Lens on slide mount, f=+100mm	09820-02	1
7	Lens on slide mount, f=+50mm	09820-01	1
8	Angular scale, laminated	09851-01	1
9	Ruler, l = 50 cm	09851-04	1
10	Illumination slit, 0.5 mm, hardpaper	09851-12	1
11	Grating, 500 lines/mm, in slide frame, glassless	09851-16	1
12	LED - red, with series resistor and 4 mm plugs	09852-20	1
13	LED - green, with series resistor and 4 mm plugs	09852-30	1
14	LED - blue, with series resistor and 4 mm plugs	09852-40	1
15	LED - UV, with series resistor and 4 mm plugs	09852-50	1
16	LED - white, with series resistor and 4 mm plugs	09852-60	1
17	Light sensor with amplifier, adjustable	09852-70	1
18	Power supply, 5 V DC	09852-99	1
19	Stray light tube	09852-71	1
20	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
21	Digital multimeter, 600V AC/DC, 10A AC/DC, 20 MΩ, 200 µF, 20 kHz, −20°C… 760°C	07122-00	1
22	Connecting cord, 32 A, 750 mm, red	07362-01	2
23	Connecting cord, 32 A, 750 mm, blue	07362-04	2

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Set-up (1/6)

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- This test shall be carried out in a fully darkened room.
- Place the white LED together with the panel holder on the tab .
- Place the tab on the tripod rods (0 cm mark of the optical axis).




Set-up (2/6)

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- Connect the LED to the power supply unit and adjust the voltage to 10 V. - Attention: Observe the correct polarity!
- The lens ($f = 50$) with a rider on the stand rod (3.5 cm from the LED).
- The lens ($f = 100$) with a rider on the stand rod (23 cm from the LED).
- Insert the lighting gap vertically into the aperture holder and place it with the rider on the stand rod (8 cm from the LED).



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Set-up (3/6)

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- The lens ($f = 50$) so that the illumination gap is evenly illuminated.
- The lens ($f = 100$) so that the gap is sharply imaged on a sheet of paper at a distance of about 70 cm from the LED.
- Clamp the photodiode in another tab and connect it to the power supply of the photodiode.




Set-up (4/6)

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- Connect a multimeter to the photodiode as voltage meter
- Measuring range: Select 2 V
- Plug the stray light tube onto the photodiode.

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Set-up (5/6)

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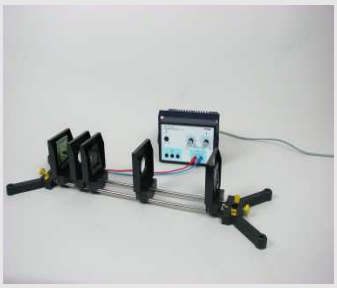
- Insert the grille vertically into the front panel holder and place it on a tab.
- Place the rider with the grille on the other end of the stand rods
- This should be about 50 cm away from the LED.



Set-up (6/6)

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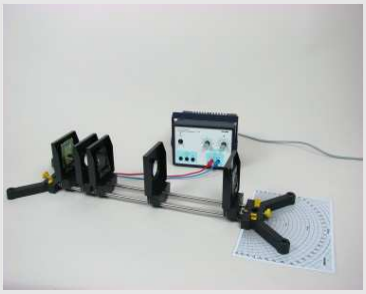

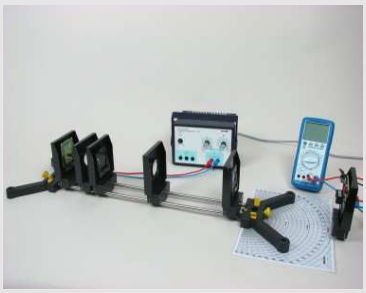

- Place the angle scale with the centre point in the middle under the tab with the grid so that the 0° axis is the extension of the ptic bench.
- Place the tab with the photodiode at the 200 mm mark of the 0° line of the angle scale (70 cm from the LED).

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Procedure (1/2)

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Procedure

- It is recommended that the green LED (operation indicator) on the photodiode be taped off, as it could falsify the measurement.
- Turn the photodiode amplifier clockwise to the stop (max. gain).
- Move the tab on which the photodiode is mounted with your foot along the line through the first order spectrum.
- Write down the following data in small steps: Color, angle and measured value of the photodiode.

Procedure (2/2)

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Procedure for the measurement

- After the measurement, walk along the line again with the photodiode to search for the maximum and note it in the measurement value series.
- The LED is then exchanged for a different color. Make sure that the rest of the optical setup does not become crazy.
- After the exchange, the measurement is carried out in the same way as for the white LED.
- This procedure is repeated until all LEDs are measured.

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Report

Task 1

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Note the measured values (in V) and the spectral colors for all LEDs - table continues with next slide.

Angle in °	Red LED		Green LED		Blue LED		UV LED	
	Color	Measure	Color	Measure	Color	Measure	Color	Measure

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Task 1

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Continuation table

Angle in °	Red LED Color	Red LED Measure	Green LED Color	Green LED Measure	Blue LED Color	Blue LED Measure	UV LED Color	UV LED Measure

Task 2

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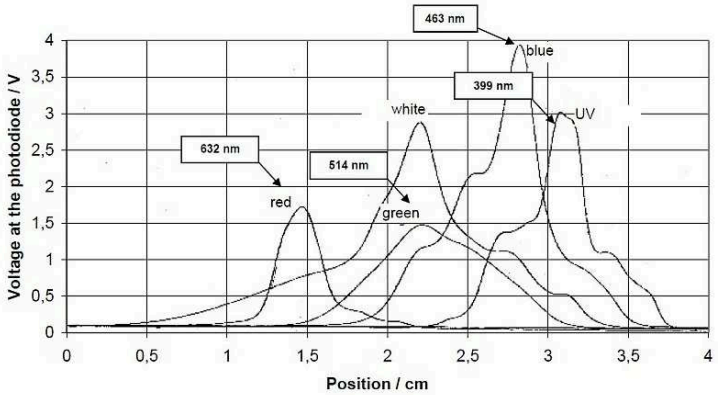

	UV LED	Blue LED	Green LED	Red LED
Wavelength in cm	399	463	514	632

Drag the right words into the gaps!

The figure shows the different courses of the _____ of the LEDs. Since the LEDs do not provide a _____ cone of light, the shape of the curves can sometimes be slightly different. But the _____ are always clearly visible.

homogeneous | peaks | spectra

Check

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Task 3

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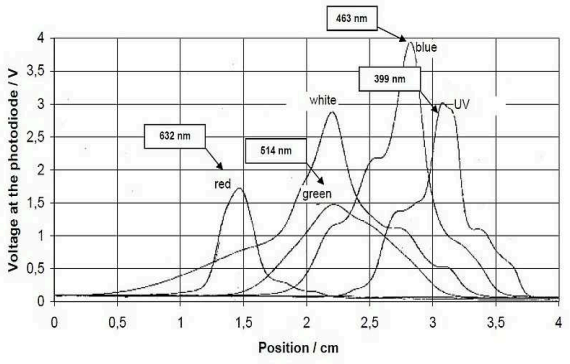

	UV LED	Blue LED	Green LED	Red LED
Wavelength in cm	399	463	514	632

Compare the measurement curves in the graph to Table 1.

Fill in the blanks!

The angle to the individual peaks of the LEDs then corresponds to the maximum in the [ ].

Check

Specify:

Proportionality factor

Intensity maximum for the white LED

Slide	Score / Total
Slide 23: Application example	0/3
Slide 24: Graphs	0/1

Total amount 0 / 4

Solutions Repeat Exporting text

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