How is light weakened when passing through materials?

Physics > Light & Optics > Wave properties of light

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/5f50622c37ffe20003f10009

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Teacher information

Application

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Experiment set-up

How is light weakened when passing through materials?

When light passes through matter or liquids, the intensity is weakened. This weakening can be detected by means of a photodiode.

In this test, the number of absorbing layers (grey filters) is changed and the light intensity is measured.

Note: The variation in the number of gray filters can be seen as a change in the thickness of a single body.

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Other teacher information

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Prior knowledge

To get the dimensions of the setup so that all slides fit between the photodiode and the LED without moving the tabs, first hold all 5 slides between the photodiode and the tube of the LED and then move the tabs together accordingly.

Tasks

As a result, the students in this experiment develop a formula for the decrease in intensity depending on the thickness of the layer through which the light passes.

Notes on implementation

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Reading the multimeter could be a little complicated in a darkened room. To be able to read the display without distorting the measured value, it is recommended to use the HOLD function of the multimeter. This involves placing the slides in the beam path, then pressing the HOLD button and then you can make some light to read the value.

Alternatively, the meter can be placed behind the photodiode, where a weak light source can be used to illuminate the display for reading.

However, the experiment can also be carried out in the physics room with dimmed light.

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Background

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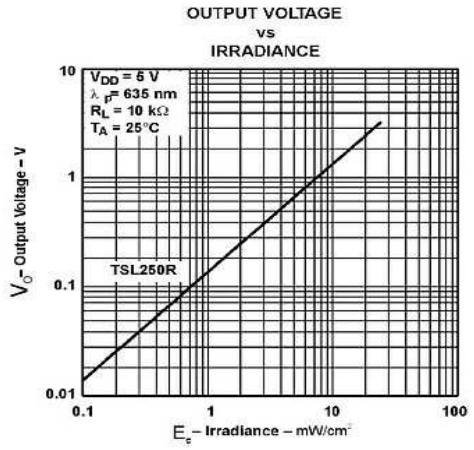

Linearity of the voltage of the photodiode over the intensity of the light incidence

Decreasing intensity due to Lambert-Beer's law:

$$l = l_0 \cdot e^{-\alpha * c * l}$$

l = distance through liquid, α-c = material-specific acceptance code.

Conversion:

$$a * c = -ln(l/l_0)/l$$

Percentage decrease per unit length:

$$p = (1 - e^{-\alpha * c * l}) * 100$$

Decrease intensity per slide about 45.68%, which proves the decrease of 50% per slide with a deviation of less than 10%.

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

Experiment set-up

How is light weakened when passing through materials?

When light passes through matter or liquids, the intensity is weakened. This weakening can be detected by means of a photodiode.

In this test, the number of absorbing layers (grey filters) is changed and the light intensity is measured.

As a result, in this experiment you will work out a formula for the decrease in intensity depending on the thickness of the layer through which the light passes.

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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	Diaphragm holder, attachable	11604-09	2
5	Foil filter grey 50% in slide frame glasless	09851-11	5
6	LED - white, with series resistor and 4 mm plugs	09852-60	1
7	Light sensor with amplifier, adjustable	09852-70	1
8	Power supply, 5 V DC	09852-99	1
9	Stray light tube	09852-71	1
10	Stray light tube for LED, Di = 8 mm, l = 40 mm	09852-01	1
11	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
12	Digital multimeter, 600V AC/DC, 10A AC/DC, 20 MΩ, 200 µF, 20 kHz, −20°C… 760°C	07122-00	1
13	Connecting cord, 32 A, 750 mm, red	07362-01	2
14	Connecting cord, 32 A, 750 mm, blue	07362-04	2

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Set-up (1/3)

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- **Note**: To carry out this experiment it is necessary that the room is darkened.
- Structure according to the illustrations
- Attach the LED with object holder to the tab and connect it to the power supply. Pay attention to the correct polarity!




Set-up (2/3)

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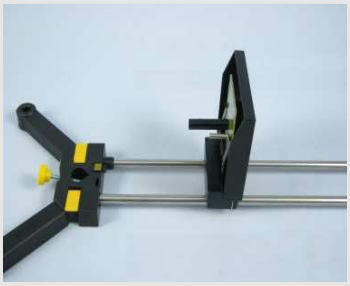
- Plug the stray light tube onto the LED.
- Also attach the photodiode with object holder to the tab.
- Connect them to the 5 V DC power supply unit.

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Set-up (3/3)

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- Connect the multimeter to the photodiode as a voltage meter.
- Set the measuring range (measuring range: greater than 4 V).

Procedure (1/2)

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Photodiode rotated

- Turn the photodiode amplifier clockwise to the stop (max. gain).
- Adjust the voltage for the LED so that the photodiode is in the sensitive range and does not overdrive.

  maximum reading about: 3.9V; adjust the brightness of the LED so that the value of the photodiode is just below 3.9V and can react up and down.

- Note the measured values of the photodiode with and without grey filter in Table 1 in the report.

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Procedure (2/2)

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Grey filter in the beam path

- Hold the first grey filter in the beam path and note the voltage at the photodiode.
- Take another grey filter and repeat the process until all 5 grey filters are in the beam path.

Attention!

- It is important to ensure that the distance between the LED and the photodiode does not change, i.e. that the slides are carefully held in the beam path.
- The photodiode reacts very sensitively to the change in distance and the measured values would be falsified!

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Report

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Task 1

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Note the voltage of the photodiode!

Number of the slides	Voltage of the photodiode in V
0	
1	
2	
3	
4	
5	

Task 2

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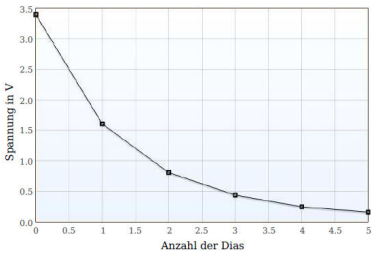
Which assumption about the relation between the number of slides and the measured photovoltage do you have by looking at the graph on the right side of table 1?



Any guess about the connection?

Umdrehen

Karte 1 von 1

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Task 3

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Can you make a statement about the correlation between the number of grey filters and the light intensity at the photodiode when you look at graph no. 2?

Drag the words into the gaps!

The measured values lie approximately on a straight line, thus establishing an _____ relationship between the number of _____ and the _____. The slope of the straight line indicates the _____ of the slides.

attenuation coefficient | exponential | decrease in intensity | absorbing layers

Check

Slide	Score / Total
Slide 18: Grey filter and light intensity	0/4

Total amount 0/4

Solutions | Repeat | Exporting text

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