How does light vibrate?

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/5f50775137ffe20003f10052

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Teacher information

Application

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Experiment set-up

How does light vibrate?

Light is a transverse electromagnetic wave, which therefore oscillates at right angles to the direction of propagation. If light is reflected at a glass pane, it is polarized, i.e. the degrees of freedom of the oscillation are restricted and the wave oscillates only in one direction.

If such polarized light hits a polarization filter that only allows light of a certain direction of oscillation to pass through, the intensity of the light is reduced or no light at all passes through.

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Other teacher information

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Prior knowledge

Since the photocurrent at the solar cell depends very much on the intensity of the incident light, care must be taken that the distance between the lamp and the solar cell does not change during the measurement. Furthermore, the less stray light that can fall on the solar cell, the more accurate the measurement.

Task

Determination of the angular dependence of the transmittance of a polarization filter with a light sensor. A relationship is established between the angle of polarization and the intensity of the transmitted light.

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

How does light vibrate?

Light is a transverse electromagnetic wave, which therefore oscillates at right angles to the direction of propagation. If light is reflected at a glass pane, it is polarized, i.e. the degrees of freedom of the oscillation are restricted and the wave oscillates only in one direction.

Determine the angular dependence of the transmission of a polarizing filter with a light sensor.

Establish a relationship between the angle of polarization and the intensity of the light shining through.

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

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Set-up (1/4)

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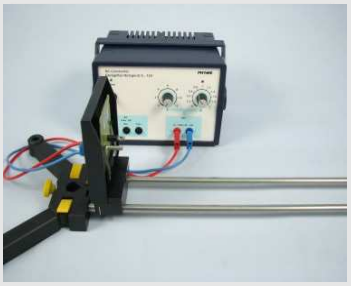
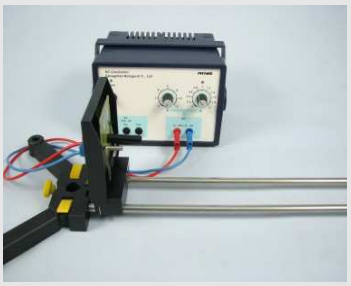
- It is necessary that the room is darkened.
- Insert the LED into an object holder according to the illustration.
- Connect the LED to the DC voltage source, paying attention to the correct polarity!
- Plug the stray light tube onto the LED.
- Also insert the photodiode into the object holder.
- Plug the stray light tube onto the photodiode.





Set-up (2/4)

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- Connect the multimeter to the photodiode as a voltage meter.
- Set the measuring range to 20V.
- Place each of the two polarizing filters in an object holder with an angle scale.
- Align them at 0°.

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Set-up (3/4)

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- Place the object holder of the first polarizing filter on the optical bench so that the filter almost touches the tube of the LED.
- Place the second polarizing filter as close as possible to the first filter.

Set-up (4/4)

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- Place the photodiode directly behind the second polarizing filter on the optical bench.

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Procedure (1/2)

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Experiment performance - Amplifier

- Turn the photodiode gain control clockwise until it stops (maximum gain).
- Set both polarizing filters to 0°.
- Adjust the voltage of the LED so that the photodiode is in the sensitive range and not overdriven.
  The maximum measured value is about 3.9 V - the LED should be adjusted so that the measured value is just below that and the photodiode can react both up and down.
- Note the measured value of the photodiode in Table 1 in the protocol.

Procedure (2/2)

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- Rotate the second polarizing filter (the one closer to the photodiode) counterclockwise in 10° steps to 100°; note the voltage value of the light sensor in Table 1.
- Then the second polarization filter is set to 0° and rotated to the left in 10° steps up to 100°, whereby the measured values are also noted in each case.

Note

- To avoid inaccuracies when adjusting the angle, the slide is removed from the rail to adjust the angle.
- It is important to ensure that the distance between the LED and the light sensor does not change. The light sensor reacts very sensitively to the change in distance and the measured values would be falsified!

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Report

Task 1

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Note the voltage at the photodiode.

*Note*The positive rotations are for when the first filter is turned clockwise. The negative rotations are for the case that the second filter is turned to the left. If the rotation is 0°, both filters are set to 0°.

Rotation in °	Voltage in V	Rotation in °	Voltage in V
-100		-10	
-90		-20	
-80		-30	
-70		-40	
-60		-50	
-50		-60	
-40		-70	
-30		-80	
-20		-90	
-10		-100	

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Task 2

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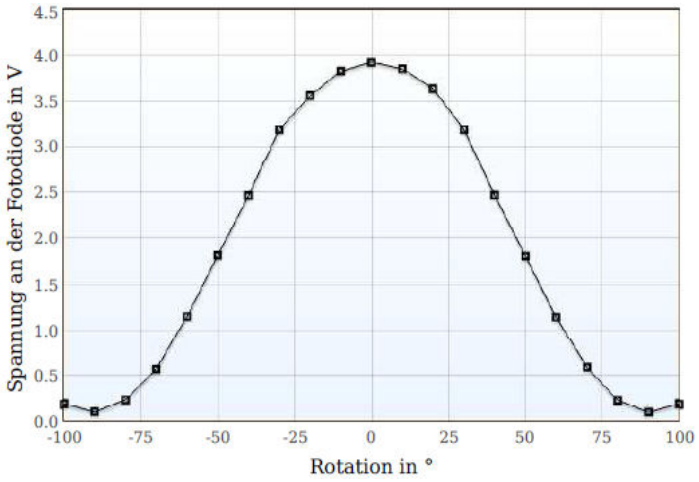
The graph could look like this:



Functional relationship between measured voltage and rotation!

The trace resembles a _____.

On closer analysis, e.g. a spreadsheet program, you will find that this is a _____.

cos-Curve | cos^2-curve

Check

Task 3

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Linear polarized light oscillates in one dimension only

- parallel to the propagation direction.
- oblique to the direction of propagation.
- orthogonal to the direction of propagation.

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Slide	Score / Total
Slide 16: Relationship between tension and rotation	0/2
Slide 17: Polarized light.	0/4

Total amount 0 / 6

Solutions | Repeat | Exporting text

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