Refraction at a prism

Physics > Light & Optics > Reflection & refraction of light

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/631b123fbce9830003710e01

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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Teacher information

Application

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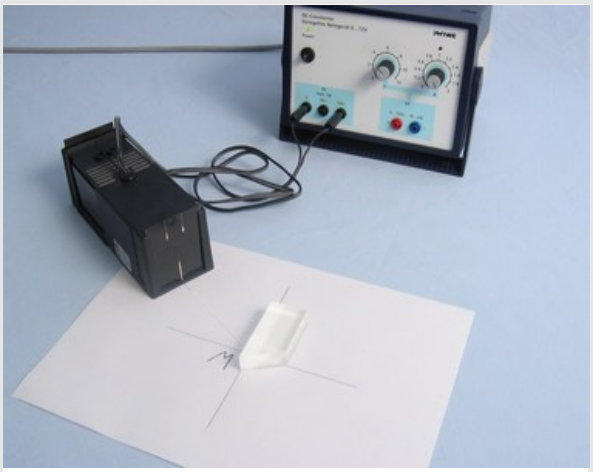

Refraction at a prism

A prism is an optical component that is used for various optical effects. It has the property of refracting light depending on its wavelength, but a prism can also be used to deflect a beam. Prisms with the latter property are also called reflection prisms and are used, for example, in reflex cameras. They correct the inverted image caused by the mirror. The deflection is also based on the phenomenon of total reflection.

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Robert-Bosch-Breite 10
37079 Göttingen

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Other teacher information (1/5)

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Prior knowledge

The students should have previously learned the basics of the straight-line propagation of light and the application of the law of reflection. They should have knowledge about the course of individual light beams when passing from glass to air and vice versa.

Principle

When the light falls on the prism, the light is refracted towards the perpendicular at the air-glass interface (transition from the optically thinner to the optically denser medium). The angle of refraction is smaller than the angle of incidence. After passing through the glass, the narrow beam of light reaches the interface between glass and air and is refracted away from the perpendicular according to the law of refraction. The angle of refraction is greater than the angle of incidence. When white light hits a prism, it is broken down into its spectral colours.

Other teacher information (2/5)

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Learning objective

With this experiment, the students should learn about the refraction of light at a prism. The knowledge about the refraction of light at the transition from air to glass or glass to air is consolidated. The division of white light into colours (dispersion) can also be observed in this experiment, but should not be discussed.

Tasks

In this experiment, the ray path through a prism is examined in the first part of the experiment. In the second part, the angle of the total deflection δ is determined as a function of the angle of incidence α of the light in focus.

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Robert-Bosch-Breite 10
37079 Göttingen

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Other teacher information (3/5)

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Additional information

In a second part of the experiment, the dependence of the angle of the total deflection at the prism on the angle of incidence of the light is demonstrated, an important optical law that is used in refractometers to determine the refractive indices of liquids and solids. The focus in terms of the students' skills here is on the precise setting and reading of the angles and the diagram representation of the measured values. This part of the experiment is therefore much more demanding in terms of the students' abilities and experimental skills. Both experiments can be seen as a unit, but it is also possible to carry them out separately.

For weaker students, only the first part of the experiment, observation of refraction at the prism, can be used.

Other teacher information (4/5)

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Notes on set-up and procedure 1

The corners of the body formed from the shorter base side and the sloping edge should match with the mark on the horizontal line. With these conditions and an incidence of light below $\alpha = 30°$,the twice refracted light beam follows an almost grazing path.

The rectangular model body is better suited for the second part of the experiment, as it also allows smaller angles of incidence. It also rests against the vertical line of the optical disc. The corner formed by the two legs should match a mark on the vertical line.

It is important for the relatively accurate determination of the total deflection that the narrow light beam coming from the light box always hits the model body exactly at the crossing point of the lines and that the model body does not change its position when the light box is moved.

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37079 Göttingen

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Other teacher information (5/5)

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Notes on set-up and procedure 2

Under these conditions, the angle of the total deflection δ is the angle between the imaginary extension of the incident light beam and the refracted light beam. The small error resulting from the vertex of the angle not being the same as the intersection of the lines on the optical axis can be neglected in view of the desired result.

From the measurement and the graphic representation, the dependency of the total deflection δ on the angle of incidence α and the minimum deflection, which is important for the technical application of the prism, are obtained with sufficient accuracy.

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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This experiment is about investigating the characteristic beam path of a prism. A prism is an optical component that is used, for example, in reflex cameras. The mirror causes the recorded image to be laterally inverted; a prism can restore the original orientation by redirecting the beam path.

Picture of a reflex camera

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Tasks

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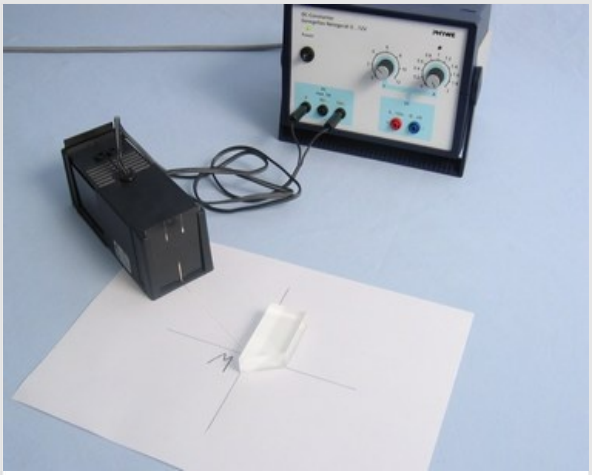

Experimental setup

How does light pass through a prism?

1. Investigate how light is refracted by a prism.

2. Determine the angle of the total deflection δ on a prism as a function of the angle of incidence α of light.

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Equipment

Position	Material	Item No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Block, trapezoidal	09810-02	1
3	Block, rectangular triangle	09810-03	1
4	Optical disk	09811-00	1
5	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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Additional material

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Position	Material	Quantity
1	White paper (DIN A4)	1
2	Protractor	1

Set-up

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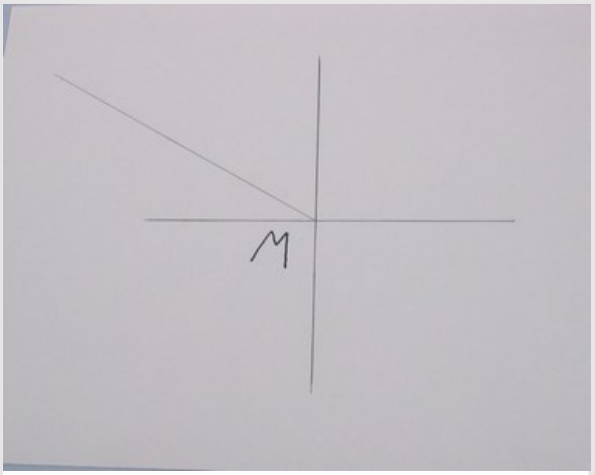

Preparation of the DIN-A4 sheet

Attention!

Make sure that the narrow beam of light coming from the light box always hits the model body exactly in the centre of the optical disc (the so-called plumb bob point) and that the model body does not change its position when the light box is moved.

1. Refraction of light at a prism

- Draw a right-angled line cross on your sheet of paper and mark the intersection with M. Carry in the item M an angle of 30° and draw a guide line.

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Procedure (1/5)

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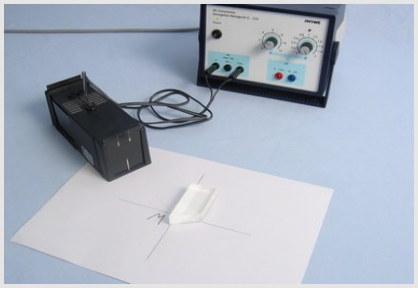
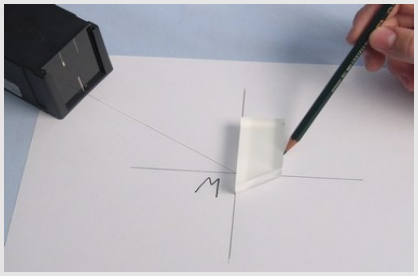
- Insert the slit diaphragm into the light box on the lens side and place it on the sheet of paper.
- Place the trapezoidal model body against the vertical line as shown on the right.
- Draw the outline of the model body with thin pencil strokes.





Procedure (2/5)

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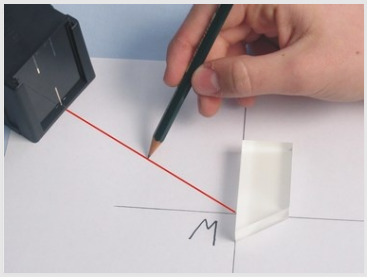

- Connect the light box to the power supply unit (12 V ~).
- Move the light box until the narrow light beam hits the model body at an angle of 30°.
- Observe the course of the narrow light beam inside and outside the model body. Write down your observations.
- Mark the incident light beam and the centre of the refracted light beam with two crosses each.

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Procedure (3/5)

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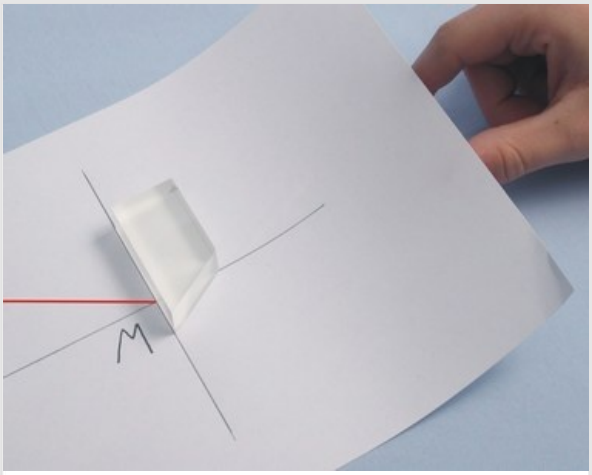

Lifting the leaf

- Lift the paper slightly diagonally into the refracted light beam and describe your observation.
- Switch off the power supply and remove the model body and the light box from the paper.
- Mark the connections so that the course of the light beam in front of, behind and inside the prism becomes clear.

Procedure (4/5)

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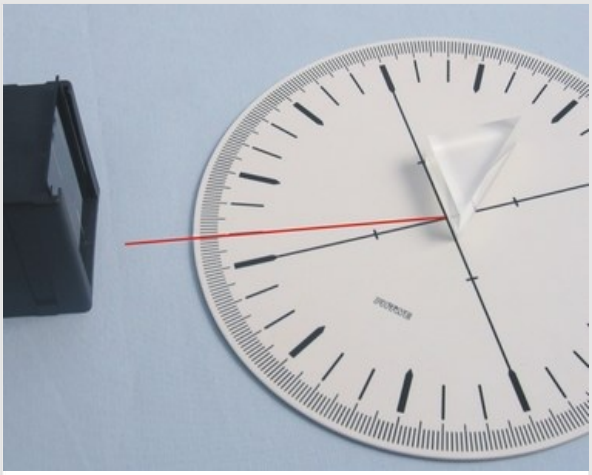

Experimental set-up for the 2nd part of the experiment

2. Determination of the angle of total deflection

- Change the experimental set-up by replacing the trapezoidal model body with a rectangular model body (roughened surface facing downwards) with a cathetus on the vertical line of the optical disc. Make sure that the right-angled corner is in line with the marking.
- Switch on the power supply again and move the light box until the narrow light beam hits the model body at an angle of 10°.

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Procedure (5/5)

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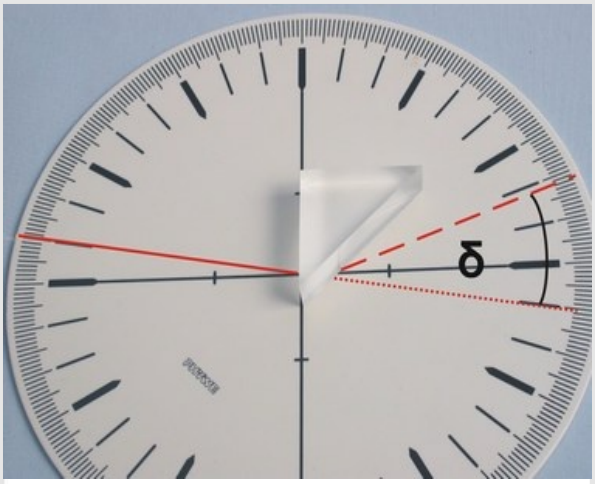
- Determine the angle of the total deflection δ and note this value.
- The angle of the total deflection δ is the angle between the imaginary extension of the incident light beam and the refracted light beam.
- Repeat the measurement for the angles of incidence of 20°, 30°, 40°, 50°, 60° and 70°. Enter the corresponding values for δ into the table in the report.
- Switch off the power supply unit.



Angle measurement

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Report

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Task 1

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Add the incident holes to the drawings of the first experiment and try to explain the course of the narrow beam of light when it hits a prism using your observations and the law of refraction. Fill in the gaps.

When the light falls on the model body, the light is refracted _____ at the air-glass interface (transition from the optically _____ to the optically _____ medium). The angle of refraction is _____ than the angle of incidence. After passing through the glass, the narrow beam of light reaches the interface between glass and air and is refracted here _____ according to the law of refraction. The angle of refraction is _____ than the angle of incidence.

greater
smaller
towards the perpendicular
thinner
away from the perpendicular
denser

Task 2

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What happens to white light that passes through a prism? Complete the following sentence.

White light, when it passes through a prism, is broken down into different colours. The violet light is refracted _____, the red light _____.

weakest
strongest

Check

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Robert-Bosch-Breite 10
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Task 3

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What conclusion did you come to?

Consider the following statement:

The angle of the total deflection δ initially decreases with increasing angle of incidence α increases, reaches a maximum and then decreases again.

○ True ○ False

Check

Task 4

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What colours does the light of the light beam refracted at the prism split into?

- ☐ Red
- ☐ Brown
- ☐ Purple
- ☐ Blue
- ☐ Orange
- ☐ Black

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Slide	Score / Total
Slide 21: Course of a narrow light beam at the prism	0/6
Slide 22: Properties of a prism	0/2
Slide 23: Angle of total deflection	0/1
Slide 24: Light splitting at the prism	0/6

Total 0 / 15

Solutions Repeat

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37079 Göttingen
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Fax: 0551 604 - 107
info@phywe.de
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