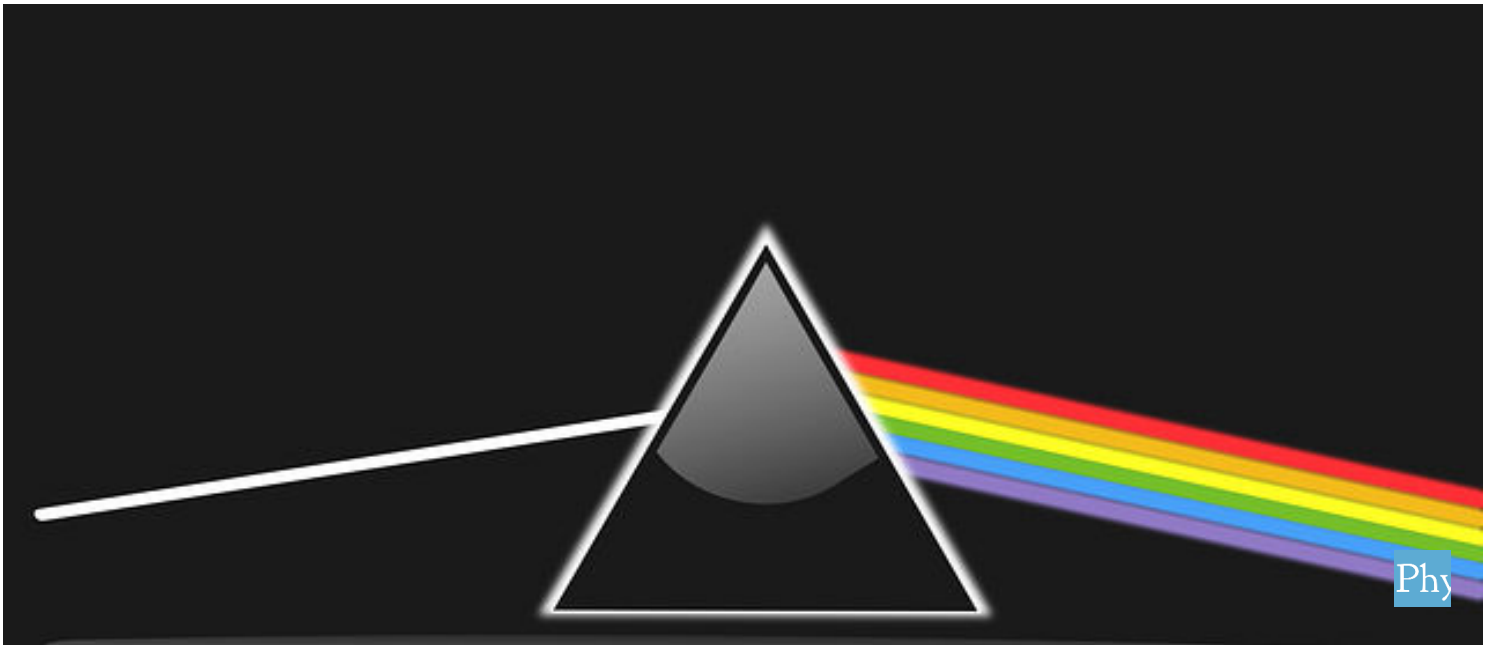
Determination of the refractive index of glass



Physics > Light & Optics > Reflection & refraction of light

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

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 of light

Whenever light passes from one medium to another medium it is refracted.

This physical effect is the basis for measuring methods such as polarimetry or refractometry.

We all know the splitting of light even from everyday life, when it is refracted by crystal glass and throws light in the colours of the rainbow onto the wall of a room.

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Other teacher information (1/4)

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Prior knowledge

Students should have previously learned the basics of linear propagation of light and the terms angle of incidence and angle of reflection. They should also know the effect of refraction from everyday life or previous attempts to do so.

Scientific principle

The observation of the incidence of light on the air-glass interface is determined by plotting the course of the light beams and is then evaluated using a semi-graphic method.

Other teacher information (2/4)

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Learning objective

With this experiment, students have the opportunity to perfect their experimental skills and consolidate their knowledge of the law of refraction.

Tasks

1. What is the refractive index?

2. Determination of the refractive index of glass.

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Other teacher information (3/4)

The experiment is demanding in terms of experimental requirements. Good results can only be achieved with careful adjustment and conscientious evaluation. But the comparison of the experimentally obtained (relative) refractive index with the tabulated value gives the student the feeling of having a relatively accurate result despite the simplified experimental conditions.

The experiment can also be used with profit in secondary school classes. Here the semi-graphic method can be applied by calculating the sine values for $\alpha$and β can be added! In this way the Snellius' law of refraction can be obtained in its quantitative version.

Other teacher information (4/4)

Instructions for construction and implementation

Care must be taken to ensure that the students adjust the model body very carefully using the light beam falling along the optical axis.

In order to obtain clear and comparable measured values for the angle of refraction and the hemi-tendon *b* the students should also make sure that the narrow beam of light always hits the plumb bob.

A displacement of the model body on the surface during the experiment also leads to incorrect results.

In order to give the students more time for the execution and evaluation of the experiment, they can also be given a prepared sheet of paper with the line cross and the entered incident light rays.

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37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Safety instructions

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- Halogen lamps become warm during prolonged use
- Avoid looking directly into the light source

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Student Information

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Robert-Bosch-Breite 10
37079 Göttingen

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Fax: 0551 604 - 107

info@phywe.de
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Motivation

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Interfaces

Refraction of light occurs at all interfaces.

This leads to phenomena such as "bent straws" or "curved" Spoons in a water glass. But also colourful rainbows are created by refraction of light at interfaces.

The intensity of refraction is determined by the refractive index, or the difference in refractive indices of the media at which light refraction takes place.

Tasks

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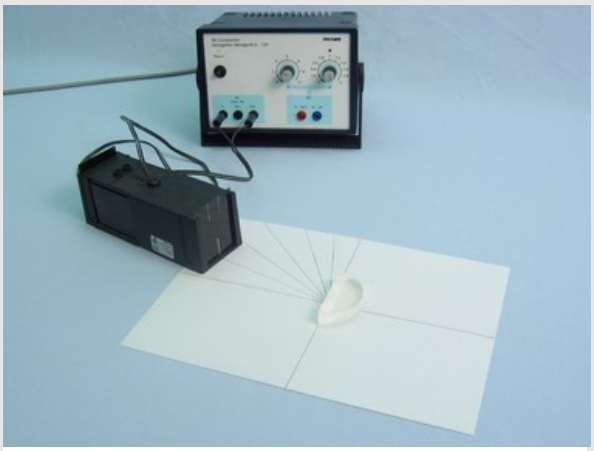

Experiment set-up

What is the refractive index?

1. Determine the refractive index of glass.

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Equipment

Position	Material	Item No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Block, semicircular	09810-01	1
3	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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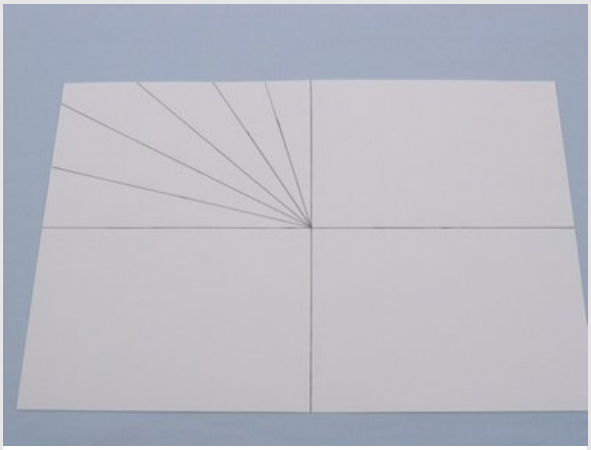
Additional equipment

Position	Material	Quantity
1	White paper (DIN A4)	1
2	Circle	1
3	Ruler (approx. 30 cm)	1
4	Protractor	1

Set-up (1/3)



Angle Scale

Look out!

Make sure that the narrow light beam coming from the light box hits the model body exactly at the intersection of the straight line (at the "perpendicular foot") and that the model body does not change its position when the light box is moved.

- Prepare a piece of paper. The cutting angle of the two straight lines must be exactly 90°.
- Draw angles of 15°, 30°, 45°, 60° and 75° at the intersection of the straight lines.

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Set-up (2/3)

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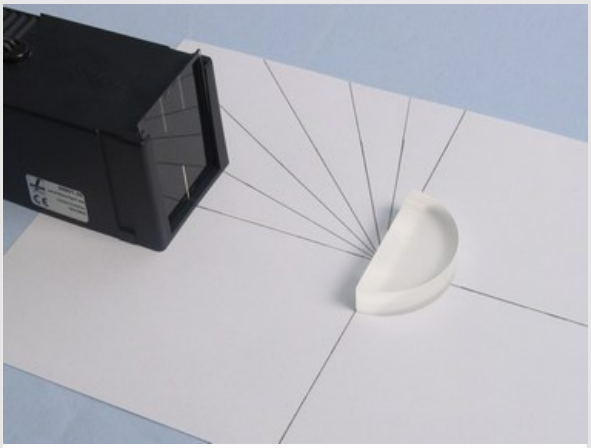

Setting up the light box

- Place the semicircular model body with the flat surface exactly on the vertical, shorter line of the line cross. The roughened surface should lie on the sheet.
- Insert the single slit diaphragm into the light box on the lens side and place it about 10 cm away from the flat surface of the model body.

Set-up (3/3)

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Connecting the light box

- Connect the light box to the power supply unit (12 V ~)

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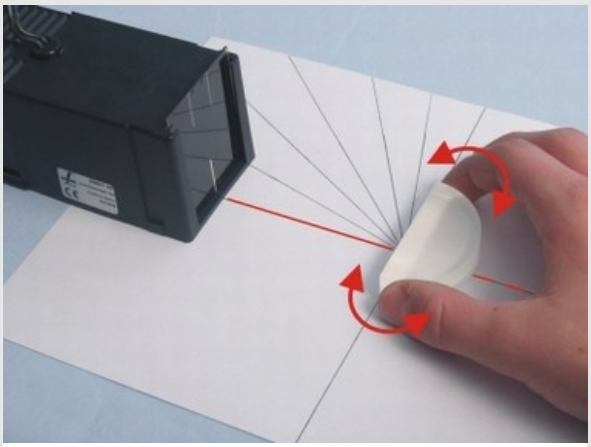
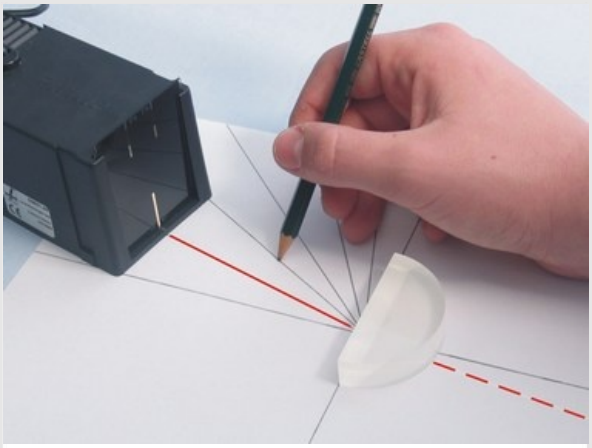
Procedure (1/3)



Using the angle scale

- Move the light box until the narrow light bundle is exactly on the optical axis (0° line, "incidence slot").
- Carefully move the semicircular model body until the narrow light beam continues along the optical axis after passing through the glass. Carefully mark the outlines of the body with thin pencil lines.

Procedure (2/3)



Marking the light path

- Now move the light box carefully until the incident light hits the model body at an angle of 15° along the previously drawn auxiliary line.
- Observe the course of the refracted light beam and compare the size of the angle of incidence $\alpha$with the angle between the refracted light beam and the angle of incidence (the refraction angle β). Note your observations in the protocol.
- Use two crosses to mark the course of the refracted light beam and, to simplify later assignment, also use one cross to mark the incident light beam.

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Procedure (3/3)

- Repeat this procedure for the other specified angles of incidence α. Mark twice the course of the refracted light beam and once the corresponding incident light beam (use different markings or colors).
- Switch off the power supply and remove the light box and model body from the paper.
- Connect the associated markings with each other and with the intersection of the straight lines so that the course of the individual light beams before and after refraction on the model body is clear.
- Measure the angle of refraction βclearly. Write the values in the table in the protocol next to the corresponding angles of incidence α.

Report

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

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Compare angles of incidence $\alpha$and angles of refraction β.

Complete the sentence.

The angle of incidence is [ ] than the angle of refraction.

Check

Table 1

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Write down your measured values in

Angle of incidence αin °	Angle of Refraction βin	a in cm	b in cm	n = a/b
15				
20				
30				
45				
60				
75				

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37079 Göttingen

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Task 1

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Compare the angle of incidence α with the corresponding angle of refraction β.
What conclusions can you draw?

The light is refracted at the transition from _____ to _____ towards the failure slot. The _____ is larger than the _____.

air
glass
angle of refraction
angle of incidence

Check

Task 2

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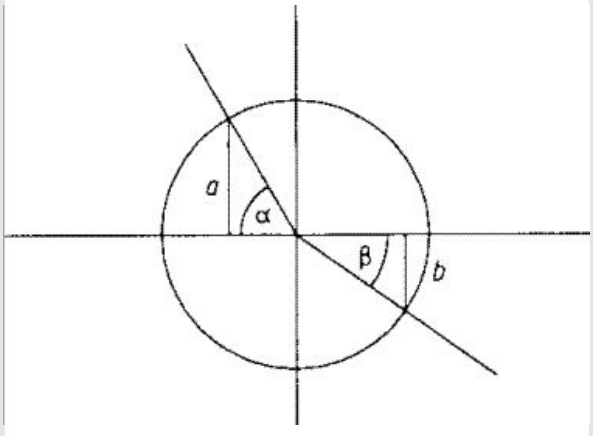

Construct a circle with a radius of 5 cm around the intersection of the crosshairs on a sheet of paper and measure the half chords a and b for each angle of incidence α and the corresponding angle of refraction β.

Enter the values that belong together in the table on the results page.

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Task 3

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Calculate the quotient n = a / b (the refractive index) for each angle of incidence $\alpha$and enter the values in Table 1.

Compare the values for n with each other. What is your conclusion?

Complete the sentence.

The values for the refractive index are approximately [ ], with increasing angle of incidence they become slightly [ ].

Check

Task 4

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Calculate the mean value of n.

The mean value of the refractive indices is

Average value

Consider which measurement errors influence the size of the refractive index n.

Possible measurement errors:

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Additional question

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Consider what statement can be made about the refraction of light at the transition from air to glass by knowing the refractive index.

The _____ of a substance, e.g. a certain type of glass, indicates how strongly light is refracted when it hits its _____ (it is a measure of the refractive properties of a body). The higher the _____, the more light is refracted at the same _____. For example, light is deflected more from its previous direction when entering _____ than when entering _____.

refractive index
refractive index
flint glass
interface
quartz glass
angle of incidence

Übergang des Lichts von Luft zu	Brechzahl n
Quarzglas	1,46
Plexiglas	1,50
Kronglas	1,53
Flintglas	1,61

Check

Slide	Score / Total
Slide 20: angles of incidence and refraction	0/1
Slide 22: Comparison of angle of incidence and angle of refraction	0/4
Slide 24: Comparison of refractive indices	0/2
Slide 26: refraction of light	0/6

Total amount 0/13

Solutions Repeat Exporting text

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37079 Göttingen
Tel.: 0551 604 - 0
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