Refraction at the glass-air boundary

Physics | Light & Optics | Reflection & refraction of light

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

This content can also be found online at:

http://localhost:1337/c/631b11babce9830003710df0

Teacher information

Application

Refraction at the transition from glass to air

The refraction of light can be described by means of ray optics. At phase boundaries, a kink in the beam path occurs due to the refraction. The change in the refractive index leads to a change in the phase velocity and thus to a deflection of the light beam.

The phenomenon of light refraction is used in medical optics, for example. Glasses and contact lenses refract light before it enters the eye, thus compensating for visual defects.

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Other teacher information (1/4)

Prior knowledge

Students should have previously learned the basics of straight-line propagation and reflection of light. The concept of a perpendicular should be known.

Principle

The light is refracted when passing from an optically thinner to an optically thicker medium (a reverse transition is also possible). When passing through the glass-to-air interface, the narrow beam of light is refracted away from the perpendicular.

Other teacher information (2/4)

Learning objective

In addition to deepening the knowledge of the law of refraction, the students' experimental skills are practised with regard to precise and careful experimentation and setting or reading angles on the optical disc. At the same time, after carrying out the experiment, there is the opportunity to discuss the reversibility of the light path and thus to theoretically support the result of the experiment.

Tasks

The aim of this experiment is to study the refraction of light as it passes from glass to air and to determine angles of refraction at some given angles of incidence.

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Other teacher information (3/4)

Notes

In connection with the answers to questions 4 and 5 in the evaluation, the experimental result is also transferred to other substances (transition of light from water to air) and the possibility is shown to discuss important application cases of refraction from the students' world of experience (bent rod in water, incorrect estimation of water depth, etc.).

Other teacher information (4/4)

Notes on set-up and procedure

The students obtain clear and comparable measured values for the angles of refraction if they carry out the adjustment of the model body and the light box very precisely and pay particular attention to ensuring that the narrow light beam always hits the plumb bob and that moving the light box during the individual experimental steps does not cause any change in the position of the model body.

The model body should lie with the roughened side on the optical disc.

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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

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Motivation

We encounter the refraction of light every day. Without this phenomenon, we would not be able to see at all, for example, because only the refraction of light in the human eye leads to an image on the retina.

Sometimes people are born with visual defects, or their vision deteriorates in the course of their lives. Glasses or contact lenses can then provide a remedy. They refract light before it enters the eye and can thus compensate for visual defects.

Refraction of light by means of glasses

Task

Experimental setup

Why do objects in the water seem to be lifted?

Investigate the behaviour of narrow light beams when light passes from glass into air and measure the angle of refraction as a function of the angle of incidence.

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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	Optical disk	09811-00	1
4	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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Set-up

Attention!

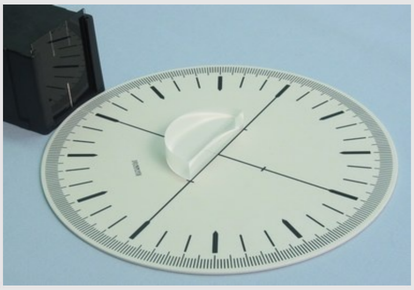
Make sure that the narrow light beam coming from the light box always runs exactly in the direction of the centre of the optical disc (to the "plumb bob") during all partial experiments and that the model body does not change its position when the light box is moved.

- Place the optical disc in front of you on the table and place the model body with the roughened surface facing downwards within the markings on the vertical line.

Experimental setup

Procedure (1/4)

- Insert the slit diaphragm into the light box on the lens side and place it about 1 cm in front of the optical disc. The semicircular side of the model body and the light box are opposite each other.



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

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Procedure (2/4)

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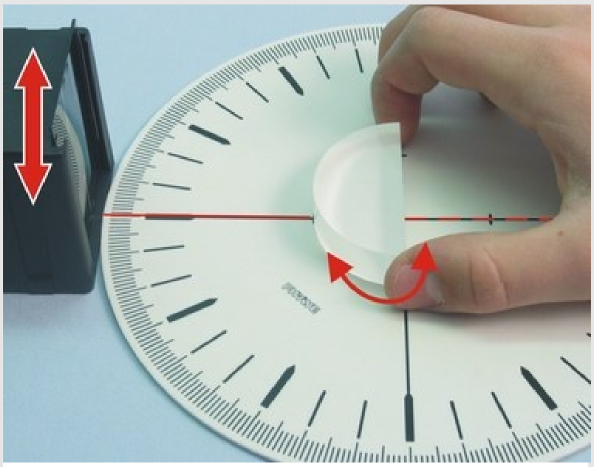

Angular adjustment of the light beam

- Move the light box until the narrow light beam runs exactly on the optical axis (0° line, the "incidence slot").
- If the model body and the light box are in the right position, the narrow beam of light will continue along the optical axis after passing through the glass.
- Now move the light box until the light falls on the model body at an angle of 10° (in relation to the incidence slot).

Procedure (3/4)

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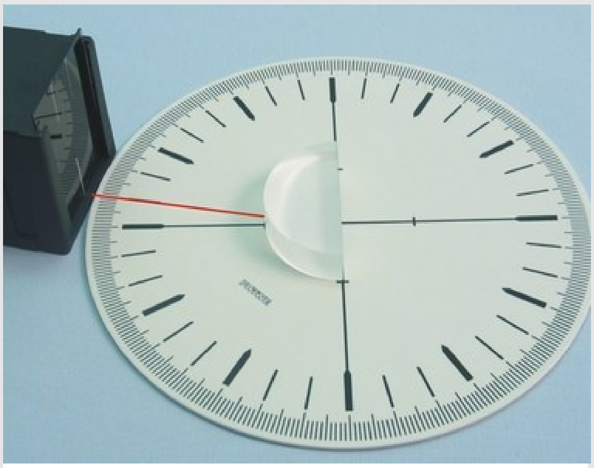

Turn the light box

- Observe the behaviour of the narrow beam of light after it has passed through the model body when it hits the glass-air interface. Write down your observations.
- Compare the angle of incidence with the angle between the emerging (refracted) light beam and the optical axis (refraction angle β). Write down your conclusions.
- Measure the angle of refraction and write down your observations.

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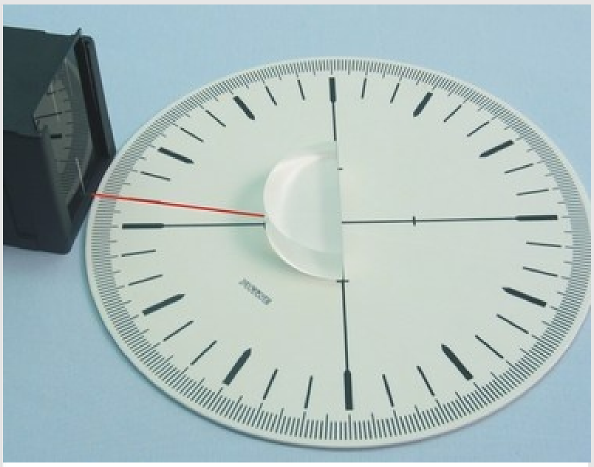
Procedure (4/4)



Turn the light box

- Use the same method and measure the angles of refraction β for the angles of incidence α of 20°, 30° and 40°. Write down your measurements.
- Observe at the angle of incidence α = 40° the behaviour of the narrow light beam at the interface between glass and air. Write down your observations.
- Switch off the power supply unit.

Report

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Task 1

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Use your observations to describe how narrow beams of light behave when incident obliquely on a glass-air interface.

When passing through the interface between glass and air, the narrow beam of light...

...bends away from the perpendicular.

...bends towards the plumb line.

Task 2

PHYWE

Compare the angles of incidence α and the corresponding angles of refraction β with each other. Fill in the gaps in the text.

When light passes from ______ into air, the ______ α is ______ than the angle of refraction β.

Check

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Task 3

Compare your observations of the narrow light beam at $\alpha = 10°$ and at $\alpha = 40°$.

What differences can you see?

Judge whether the following statement is true or false.

At an angle of incidence of 40°, a reflected light beam can also be observed inside the body. Furthermore, the refracted light beam has coloured edges.

- True
- False

Check

Task 4

Try to make a guess as to how narrow beams of light emitted from a light source under water (e.g. a diving lamp) behave when they pass through the water-air interface.

- Since water behaves similarly to glass in refraction (both substances are optically denser than air), narrow beams of light are also refracted away from the perpendicular when water passes into air.
- Since water behaves in the opposite way to glass in refraction, narrow beams of light are refracted towards the perpendicular when water passes through air.

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Task 5

Try to explain why objects in the water appear to be raised.
Fill in the gaps in the text below.

Any beam of light emanating from an object under water and reaching our eye is ______ into air when it hits the ______ of water ______. Our brain, however, assumes on the basis of ______ that the light propagates ______. It therefore moves the ______ of the light beam to a ______ position compared to the actual position.

- starting point
- raised
- experience
- interface
- in a straight line
- at an angle
- refracted

Check

Slide	Score / Total
Slide 18: Behaviour at the interface between glass and air	0/1
Slide 19: Comparison of angle of incidence and angle of refraction	0/3
Slide 20: Observation of the course of a narrow light beam	0/1
Slide 21: Behaviour at the water-air interface	0/1
Slide 22: Objects in the water	0/7

Total 0 / 13

Solutions Repeat

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