Refraction at the transition from air to glass

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/5f4dc422ce572a000382d7cf

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Teacher information

Application

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Refraction of light at interfaces

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

This experiment deals with the refraction at the transition from air to glass. This can be found, for example, in glasses or when looking at a glass of water.

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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 be able to designate angles and measure them in relation to the angle of incidence.

Scientific principle

With the help of self-selected values for the angle of incidence $\alpha$and the check for the angle of incidence $\alpha = 0^\circ$ they should gain the general validity of Snellius' law of refraction in a qualitative form and recognise its conditions of validity.

Other teacher information (2/4)

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Learning objective

In this experiment, the students have the task of studying the refraction of light at the transition from air to glass and the angles of refraction $\beta$for given angles of incidence α to measure. In doing so, they should ultimately come to conclusions regarding the legal dependence and formulate these conclusions.

Tasks

1. study of the behaviour of narrow beams of light when light passes from air into glass.

2. measurement of the angle of refraction as a function of the angle of incidence when light passes from air into glass.

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Other teacher information (3/4)

Answering questions 2 and 4 in the evaluation makes high demands on the students' physical understanding. Therefore, help is necessary here.

On the other hand, it is precisely the discussion about the case $\alpha = 0^\circ$ makes sense with regard to the validity conditions of physical laws.

Other teacher information (4/4)

Notes on construction and implementation

The method of adjusting the model body with the help of the light beam incident along the optical axis is a simple but also precise possibility. This procedure should therefore be practiced, since an intermediate control during the experiment is useful to avoid measurement errors.

In order to obtain clear and comparable measurements of the angle of refraction, students should also ensure that the narrow light beam is always exactly in the centre of the optical disc (the plumb bob), and that any displacement of the model body on the surface during experimentation will also lead to incorrect results.

Although the simultaneous reflection at the air-glass interface is of secondary importance, students should observe this phenomenon at the transition from the optically thinner to the optically denser medium, in view of the total reflection to be dealt with later and its understanding.

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Safety instructions

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

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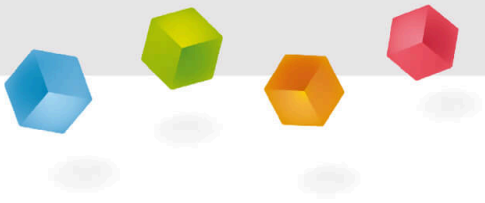

Student Information

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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 most frequently considered interface in everyday life is probably the interface between air and glass, which is also the subject of this experiment.

Tasks

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Experiment set-up

What does refraction of light mean?

1. to study the behaviour of narrow beams of light when light passes from air into glass.

2. measure the angle of refraction as a function of the angle of incidence when the light passes from air into 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	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 (1/2)

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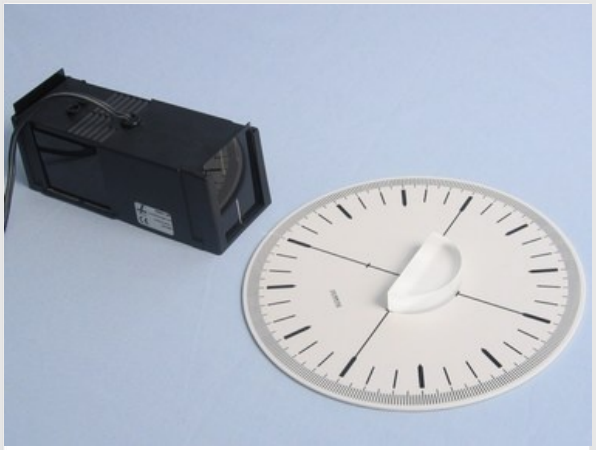

Experiment set-up

Look out!

Make sure that the narrow light beam coming from the light box is always exactly in the centre of the optical disc during all partial tests and that the model body does not change its position when moving the light box.

- Place the optical disc in front of you on the table and place the semicircular model body (roughened side down) exactly on the vertical line within the marks.
- Insert the slit diaphragm into the light box on the lens side and place it in front of the optical disc with a distance of about 1 cm.

Set-up (2/2)

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Connecting the light box

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

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Procedure (1/4)

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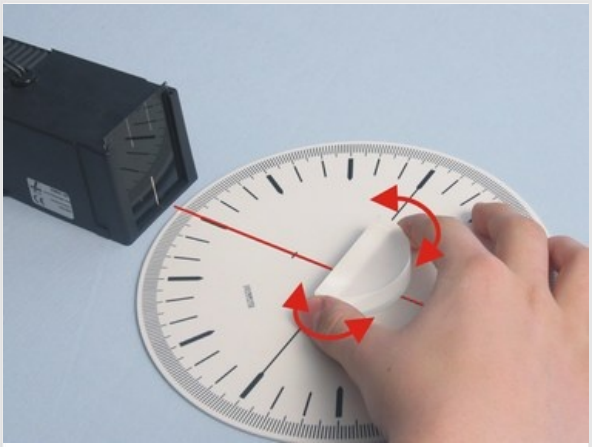

Use of the circular disc

1. the behaviour of narrow beams of light at the air-glass interface

Move the light box until the narrow light beam is exactly on the optical axis (0° line, the "incidence slot"). When the model body and the light box are in the correct positions, the narrow light beam will continue along the optical axis after passing through the glass.

Procedure (2/4)

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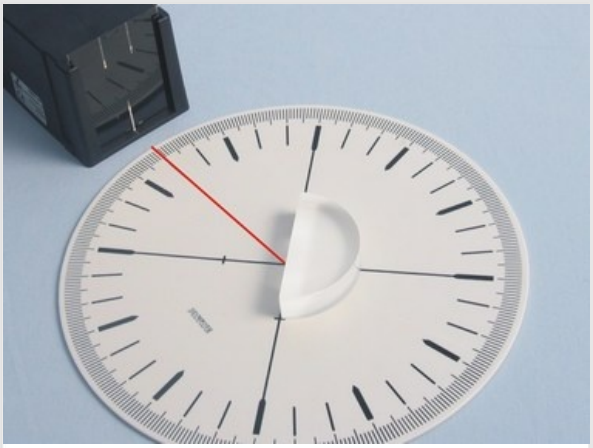

Positioning the light box

- Now move the light box until the light is incident on the model body at an angle of 40° (relative to the incidence angle).
- Observe very closely the behaviour of the narrow light beam when it strikes the air-glass interface.
- How does the light behave when it leaves the vitreous body (at the interface between glass and air)?
- Compare the size of the angle of incidence α with the angle between emerging (refracted) light beam and the optical axis (angle of refraction β). Note your observations in the protocol.

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Procedure (3/4)

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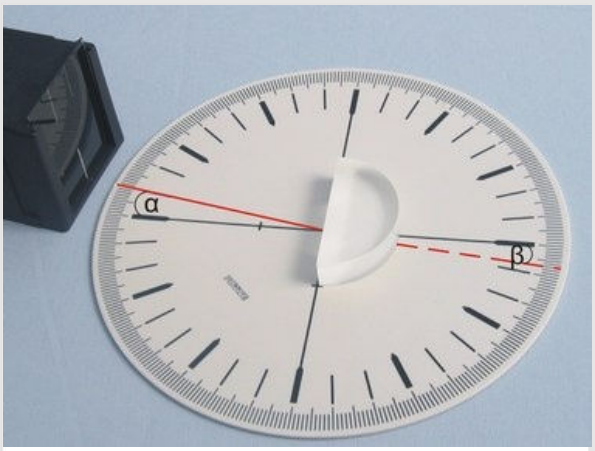

Determination of the angle of refraction

2. determination of the angle of refraction β

- Check the adjustment of the model body according to the procedure described in the first partial test (incidence and exit of the light exactly along the optical axis).
- Now move the light box until the incident light beam encloses exactly the angle of 10° with the angle of incidence (0° line).
- Read the corresponding refraction angle $\beta$and enter the measured value in Table 1 What is the angle between the refracted light beam and the perpendicular (optical axis).

Procedure (4/4)

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Determination of the angle of refraction

2. determination of the angle of refraction β (continued)

- Repeat this procedure for the angles of incidence α of 30°, 45°, 60° and 75° and enter the corresponding refraction angle $\beta$is also entered in the table.
- Choose three angles of incidence yourself $\alpha$and measure the corresponding refraction angles β. Also note these values in Table 1.
- Finally, let the light enter at the angle of incidence of 0°. What is now the angle of refraction β? Write down your reading.

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Report

Observations (1/3)

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Write down your observations for test part 1.

a) Behaviour of the narrow light beam at an oblique angle to the air-glass interface.

The majority of the narrow light beam is _____ at the air-glass interface, but a small proportion is also _____.

reflected

refracted

Check

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Observations (2/3)

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Write down your observations for test part 1.

b) Behaviour of the narrow light beam when it exits the model body.

When it exits the model body, the light beams are _____ ; _____ of the light can be observed.

straight

no refraction

Check

Observations (3/3)

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Write down your observations for test part 1.

Complete the sentence.

(c) comparison of angle of deflection and angle of refraction.

The angle of incidence α is _____ than the angle of refraction β.

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Table 1

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Determination of the angle of refraction β depending on the angle of

Angle of incidence α in °	Angle of Refraction β in °
15	
20	
30	
45	
60	
75	

Task 1

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Using your observations, describe how narrow beams of light behave when incident obliquely on an air-to-glass interface.

At the interface of _____, narrow beams of light are _____. (However, part of the light is also reflected according to the _____).

air to glass | refracted | law of reflection

Check

Compare the angles of incidence with the corresponding angles of refraction β with each other. Formulate the result.

When the light passes from _____ the _____ greater than the _____.

air to glass | angle of incidence α | angle of refraction β

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Task 2

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What was the result of the measurement at an angle of incidence of 0° ?
Try to give a reason for your result.

With an _____ of 0°, the _____ is also 0°. Since the angle of refraction is _____ than the angle of incidence when light passes from air to glass, this angle of refraction could be smaller for $\alpha = 0^\circ$ must only be _____. But this is not possible, so the light is not refracted at this _____.

- less than 0°
- angle of refraction
- angle of incidence
- always smaller
- angle of incidence

Check

Task 3

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Based on your measurements and the experimental conditions, try to formulate a law for the light transfer at the air-glass interface.

If narrow beams of light pass from air to glass at an angle of incidence _____ than 0°, the _____ is _____ than the angle of _____.

- greater
- angle of refraction
- incidence
- smaller

Check

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Task 4

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Why is the light beam not refracted again when stepping out of the semicircular model body?

When the light beam _____ the model body, it is _____ refracted again, since in this case the light is _____ on the interface, i.e. the _____ is 0°. The light beam runs along the radius of the model body and thus perpendicular to the semicircular _____.

not
exits
angle of incidence
boundary surface
right

Check

Slide	Score / Total
Slide 19: Light beam behaviour: air to glass	0/2
Slide 20: Behaviour light beam: Exit model body	0/2
Slide 21: angle of deflection and refraction	0/1
Slide 23: Multiple tasks	0/6
Slide 24: angle of incidence of 0	0/5
Slide 25: Light transition at interface	0/4
Slide 26: Refraction on semicircular model bodies	0/5

Total amount 0 / 25

Solutions Repeat Exporting text

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