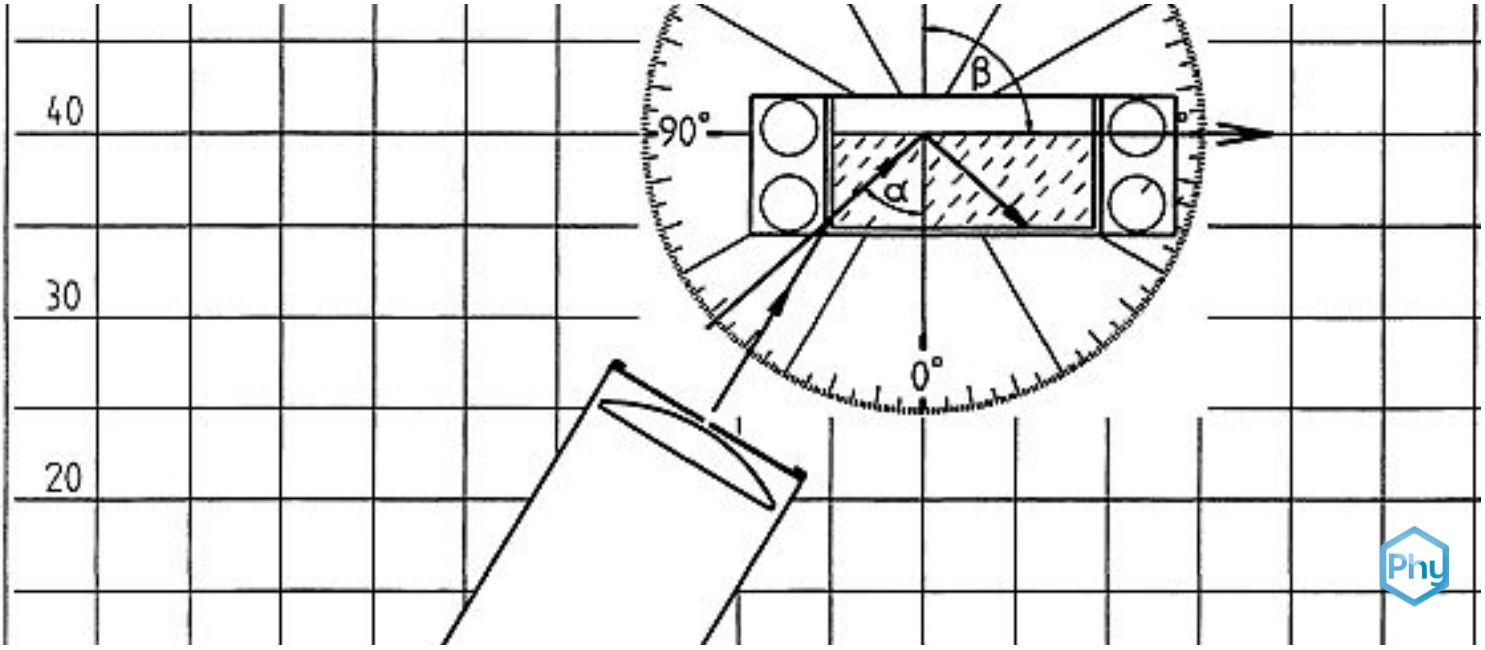
Total reflection of light at the water-air transition



Physics | Light & Optics | Reflection & refraction 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/6428745100751500022ed006

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Teacher information

Application

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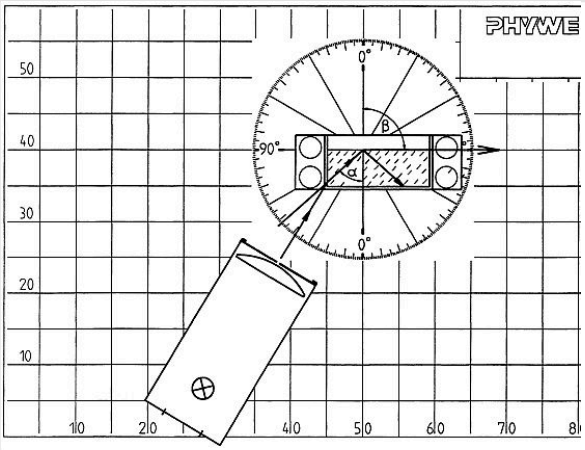

Experimental set-up:

Total reflection water-air

Just as in the transition between Plexiglas and air, there is also a refractive index between water and air.

In this experiment, the angle of total internal reflection is determined for the transition between water and air.

Depending on the different refractive indices n, of two transition media, different limiting angles for the total reflection thus also arise.

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Other teacher information (1/2)

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Prior knowledge

Students need prior theoretical knowledge about the straight-line, ray-shaped propagation of light. They should have gained experience about total reflection.

Principle

It is to be demonstrated that light is totally reflected when passing from water into air if the angle of incidence is α greater than a certain critical angle α_G is;

α_G is to be determined.

Other teacher information (2/2)

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Learning objective

The students should observe under which conditions the light is refracted and when it changes to reflection. Furthermore, they should understand that the refractive index influences the critical angle α_G of light.

Tasks

The students should observe the measurement of the light rays and determine the critical angle α_G.

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Additional teacher information

Note

The results of this experiment can be used to determine the refractive index n for the water-air transition:

Breaking law $\frac{sin\alpha}{sin\beta} = n$

$sin\beta = 1$ because of $\beta = 90^\circ; \alpha = 48^\circ$

$n = sin(48^\circ) = 0,74 \approx 3/4$

Safety instructions

- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student information

Motivation

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Waveless lake reflects tree

By now you have learned a lot about reflection and refraction.

In the picture opposite, you can see how, in an attempt at total reflection of glass, water is also able to function like a mirror.

This experiment is intended to show when water reflects light and when it merely refracts the beam.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Halogen lamp for experiments, 12V/50W, with magnetic base	08270-20	1
3	Concave/convex mirror,magnet held	08270-12	1
4	PHYWE Multitap transformer DC: 2/4/6/8/10/12 V, 5 A / AC: 2/4/6/8/10/12/14 V, 5 A	13533-93	1
5	G-clamp	02014-00	2

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Set-up and Procedure (1/2)

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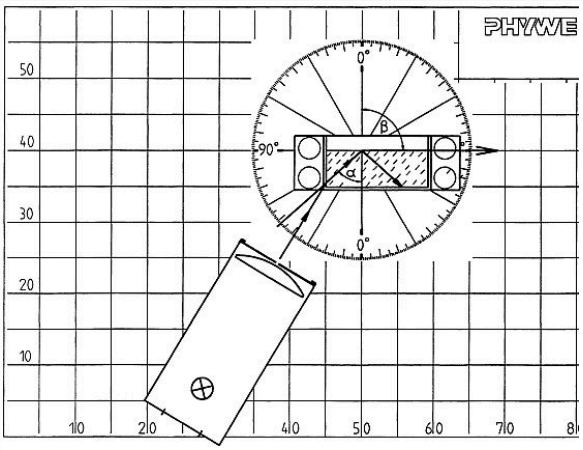

1-gap orifice directed to water-air transition

- Place optical disc in the upper half of the panel
- Place the cuvette filled with water so that the water level is at the same height as the horizontal diameter of the optical disc and move the cuvette slightly to the right.
- Position the adhesive luminaire with 1-slit aperture so that the light beam runs unbroken along the vertical axis of the optical disc; readjust the cuvette if necessary.

Set-up and Procedure (2/2)

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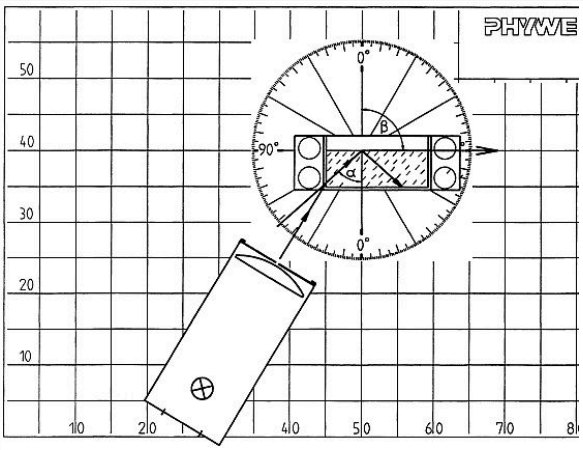

1-gap orifice directed to water-air transition

- Move the adhesive luminaire; the beam refracted when entering the water should always pass from water into air at the centre of the optical disc.
- Observing ray trajectories at the water-air transition
- Measure the angle of incidence α_G , in which the angle of refraction β has the value 90°; to do this, extend the incident beam running in the water up to the angular division of the optical disc (cf. dashed line).
- Move the luminaire further;$\alpha > \alpha_G$

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Report

Task 1

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Fill in the blanks!

The light is refracted away from the plane of incidence during the _____ from water to air.
If the angle of incidence reaches the value _____, then the refracted beam travels in such a way that it _____ the interface. If $\alpha > 48^\circ$ then the light is reflected at the interface according to the _____. Also in the case of _____, part of the light is reflected at the interface; with _____ being completely (totally) reflected.

$\alpha > 48^\circ$
brushes
$\alpha < 48^\circ$
48°
law of reflection
transition

Check

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Task 2

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When passing from an optically denser to an optically thinner medium, light becomes....

- broken when α_G is exceeded.
- always totally reflected.
- totally reflected when α_G is exceeded.

Task 3

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The critical angle for the water-air transition is:

- ○ 48°
- ○ 2/3
- ○ 42°
- ○ 90°

Check

The observed phenomenon is called:

- ○ Total refraction
- ○ Refractive index
- ○ Total reflection
- ○ dense medium

Check

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Slide	Score / Total
Slide 13: Transition from water to air	0/6
Slide 14: Optical medium transition	0/2
Slide 15: Multiple tasks	0/2

Total 0 / 10

Solutions Repeat

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