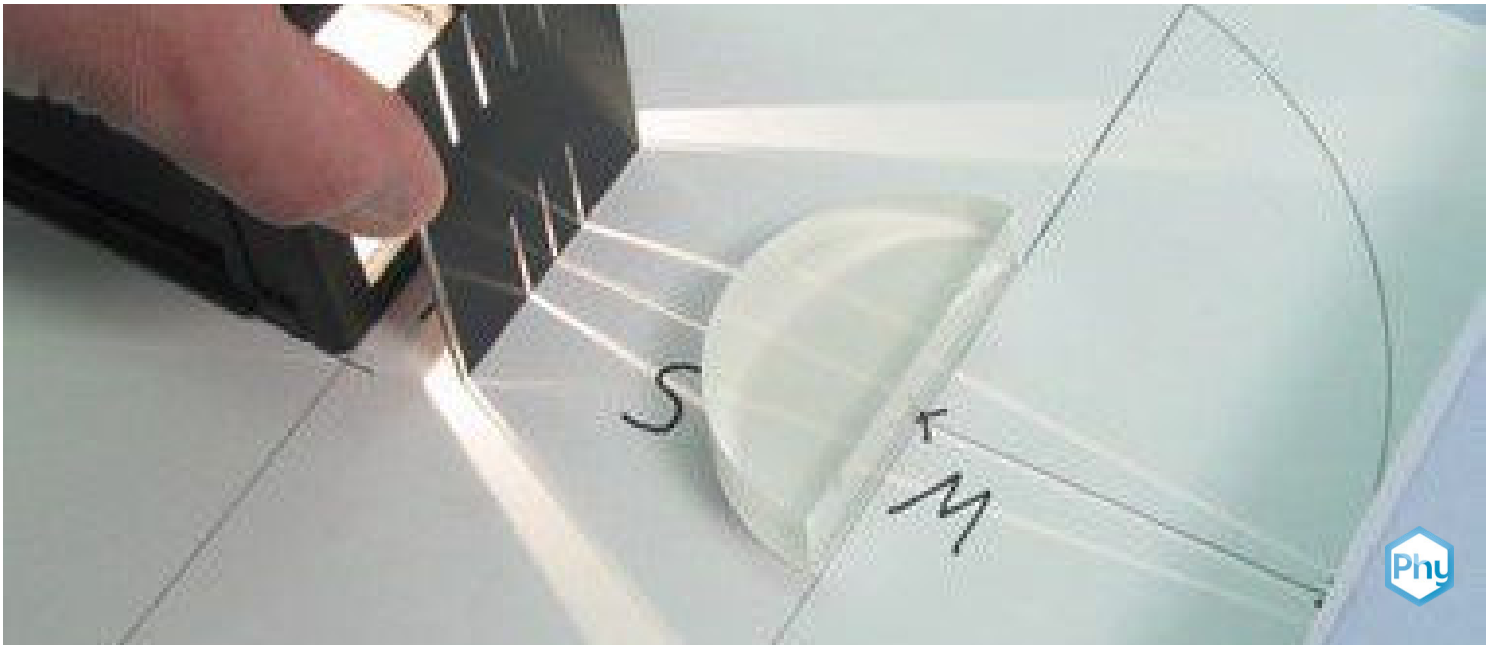
Short-sightedness and its correction



The aim of the experiment is to use an eye model to investigate how short-sightedness affects the vision of distant or near objects and by what means it can be corrected.

Physics > Light & Optics > Optical devices & lenses

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/6330354abdd06200034b24c6

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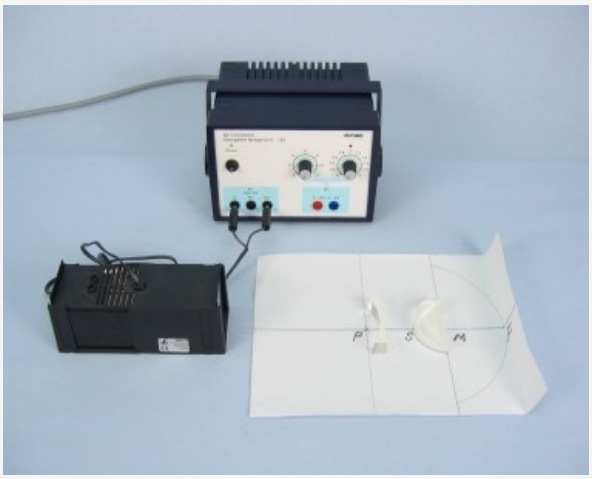
Teacher information

Application



Myopia and its correction

Myopia, short-sightedness, is a specific type of optical defect of the eye. It is caused by the image being focused in front of the retina. As a result, distant objects appear blurred to the observer. The causes of short-sightedness are a too long eyeball or a too high refractive power of the optically effective components of the eye (cornea, eye lens, vitreous body etc.). Glasses or contact lenses can shift the focal point back to the retina and thus correct the aberration. It is estimated that almost 25% of people worldwide are affected by myopia. If left untreated, it is considered a long-term threat to vision and can lead to glaucoma and cataracts, for example.

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Application

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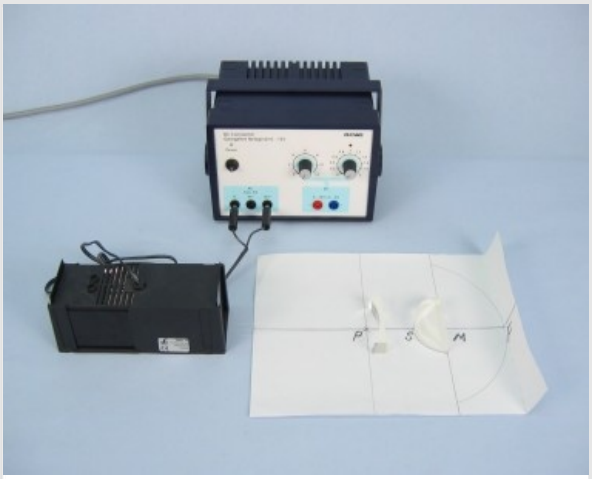

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Other teacher information (1/6)

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Prior knowledge

The light path on convex lenses should be known.

Principle

Light from objects far away from the myopic eye is refracted through the lens of the eye and coalesces in front of the retina.

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Other teacher information (2/6)

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Learning objective

The students consolidate their knowledge of the course of light in convex lenses. Using the example of correcting the short-sighted eye with the help of a plano-concave lens, the application of physical laws of optics for the benefit of humans is clarified. At the same time, the knowledge about the eye's ability to accommodate is repeated and examined again experimentally using the example of divergent incident light.

Tasks

The aim of the experiment is to use an eye model to investigate how short-sightedness affects the vision of distant or near objects and by what means it can be corrected.

Other teacher information (3/6)

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Additional information

The experiment is demanding in terms of skills and abilities, especially due to the necessary abstraction from the plane model to the real eye. In addition to a clear idea of the structure of the human eye, this also requires a basic understanding of the formation of images on the retina.

This series of experiments can make a significant contribution to understanding everyday perceptions (spectacle wearers, how spectacle optics work) and also with regard to social communicative behaviour (understanding behaviour towards spectacle wearers).

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Other teacher information (4/6)

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Notes on set-up and procedure 1

In contrast to the experiment "Functioning of the human eye", the semicircular convex lens is used as a model for the eye lens in this experiment. Accommodation to objects close to the eye is simulated by adding the narrow plano-convex lens. For the student, difficulties in understanding may arise in connection with the geometry of the myopic eye. This can be prevented by providing appropriate support for the construction of the real short-sighted eye.

If the preparation and set-up instructions are followed carefully, a clear experimental result can be expected.

Other teacher information (5/6)

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Notes on set-up and procedure 2

The upwardly folded edge of the sheet of paper prevents the observation of the course of light behind the retina of the short-sighted eye, which is uninteresting with regard to the objective of the experiment. It should be noted that the arc of a circle that is to represent the retina is not constructed around M, but around S. This is also useful for the farsightedness test with a view to uniform and thus simplified test preparation. The marking of the course of the light bundles serves the subsequent discussion of the light path for objects far away from the eye when correcting myopia. Therefore, a mark should also be made between the concave lens and the lens of the eye.

When observing with divergent incident light, a three-slit diaphragm is held in front of the eye lens so that a clear intersection of light beams can be observed. The position of the diaphragm also influences the position of the intersection point, as thick lenses have different focal lengths for near-axis and far-axis light beams. The specified distance to the eye lens should therefore be observed.

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Other teacher information (6/6)

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Note

In most cases, the defective vision is not due to a disturbed accommodation ability of the eye, but to a too large (short-sightedness) or too small (long-sightedness) image distance, which corresponds to the distance of the retina to the eye lens. This is why short-sighted people are able to image nearby objects sharply on the retina even with little accommodation of the eye. This is demonstrated in the experiment by the smaller distance of the near point (position of the light box at P) was reproduced as a model. In comparison with the evaluation of the farsightedness experiment (need for strong correction for objects close to the eye), this fact should be addressed.

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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Myopia, short-sightedness, affects an estimated 25% of the world's population. It is an optical defect in which the focal point is located in front of the retina instead of on the retina. In most cases, this visual impairment is congenital or develops in the course of life. With the help of glasses or contact lenses, however, the focal point can be moved back to the retina and the visual defect corrected.

Short-sighted people see objects in the distance out of focus, but can see close objects normally.

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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	Block,planoconvex lens,fl+100mm	09810-04	1
4	Block, planoconcave lens,fl-100mm	09810-05	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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5	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Additional equipment

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

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Set-up (1/2)

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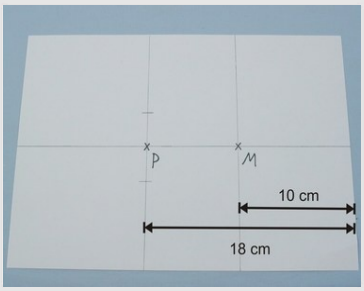
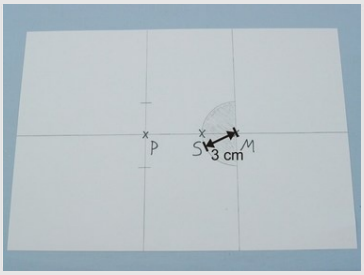




Attention!

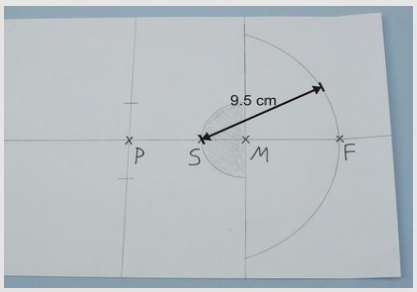
Make sure that the semi-circular eye lens always lies with its flat surface on the vertical line of the line cross and does not change its adjusted position when moving the light box.

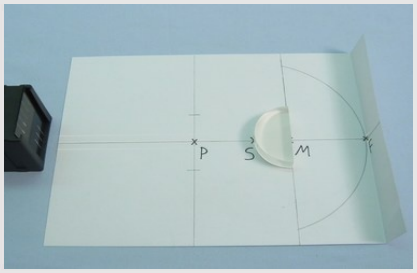
- Prepare your sheet of paper for the experiment. Draw a right-angled cross of lines at 10 cm and 18 cm from the right edge (the intersection of the lines is M resp. P) and at a distance of 3 cm from P one mark each on the vertical line.
- Draw a semicircle around M with a radius of 3 cm. Let the point of intersection with the optical axis be S. Shade this semicircular area.

Set-up (2/2)

PHYWE

- Draw another arc, but around S and with radius 9.5 cm. Let the point of intersection with the optical axis be F. This arc represents the retina of the myopic eye in your eye model.
- Fold the sheet of paper upwards 3.5 cm from the right edge as a screen. The dot F lies in the folded edge.
- Place the semicircular convex lens on the hatched area with the flat side exactly on the vertical line of the line cross. This lens represents the lens of the eye in your model.
- Insert the three-slit aperture into the light box on the lens side and set up the light box.





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Procedure (1/4)

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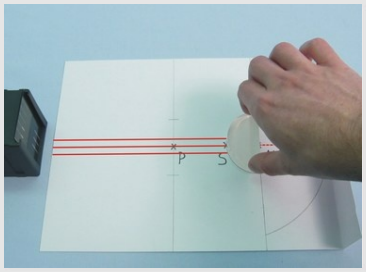

1. Seeing distant objects

- Connect the light box to the power supply unit (12 V ~) and switch on the power supply unit.
- Move the light box until the middle light beam runs exactly along the optical axis and passes through the lens unbroken.
- If this is not the case, carefully move the lens a little along the vertical line (adjusting the arrangement).
- Observe the path of the parallel light after it has passed through the lens of the eye and describe the image on the screen and the position of the focal point.

Procedure (2/4)

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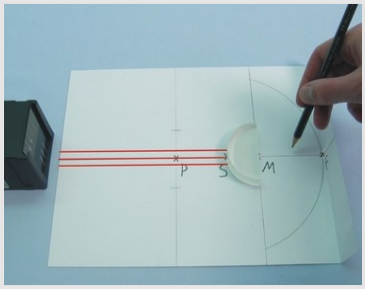

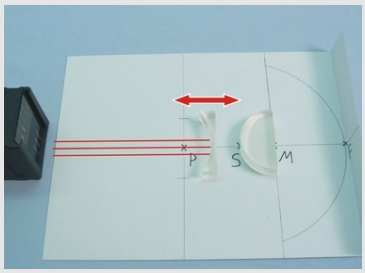

- Mark and label the collection point of the parallel incident light with F_1.
- Place the plano-concave lens in front of the semi-circular lens. Observe and describe again the course of the light, especially the position of the focal point.
- Move this plano-concave lens a little. Where can you use it to move the collection point of the incident light?
- In this case, mark the outline of the lens and, always with two crosses, the incident and refracted light beams in front of, between and behind the lenses.
- Take the plano-concave lens off the paper.

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Procedure (3/4)

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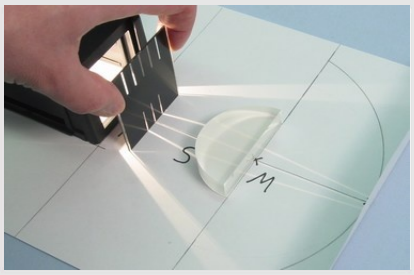
2. Seeing close objects

- Turn the light box 180° and remove the diaphragm so that divergent light now falls on the lens of the eye.
- Move the light box up to the vertical line (point P), whereby it should stand within the markings.
- Hold the three-slit diaphragm about 2 cm in front of the eye lens so that the central beam of light runs along the optical axis.
- Observe the course of the light behind the lens and when it hits the screen. Write down your observations.



Procedure (4/4)

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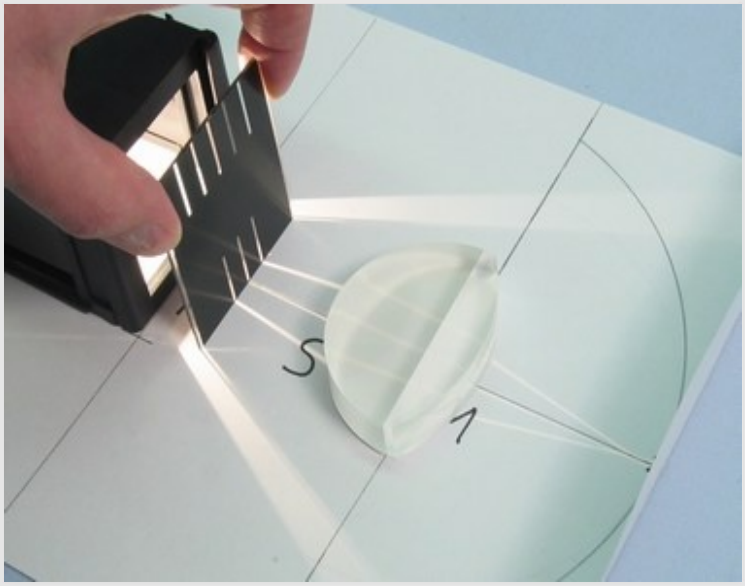

- Place the narrow plano-convex lens with the flat surface against the semi-circular lens. Observe the change in the course of the light, especially when it hits the screen, and note your observation again.
- Switch off the power supply and remove the light box and the model body from the paper.

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Report

Task 1

10° PHYWE

Compare the situation of F (intersection of the arc around S with the optical axis) with the position of the point F_1.

- ○ The intersection F_1 of the parallel incident light lies on the point F, i.e. on the arc of a circle.
- ○ The intersection F_1 of the parallel incident light lies behind the point F, i.e. behind the arc.
- ○ The intersection F_1 of the parallel incident light lies in front of the point F, i.e. in front of the arc.

Check

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Task 2

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10°

Nearly parallel light emanates from object points far away from the eye. Formulate a statement about the course of the light in the short-sighted eye for distant objects.

- Light from objects far away, from the myopic eye, is refracted through the lens of the eye and combines on the retina.
- Light from objects far away, from the myopic eye, is refracted through the lens of the eye and combines in front of the retina.
- Light from objects far away, from the myopic eye, is refracted through the lens of the eye and combines behind the retina.

Task 3

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Connect the matching crosses on your sheet of paper so that the course of the light beams through the lenses becomes visible. What changes when a plano-concave lens is placed in the light path? Fill in the gaps in the text.

With the help of a _____ at a suitable distance from the _____, the light can be _____. The point of intersection of _____ incident light can thus be shifted to the _____.

eye lens
plane concave lens
diverged
retinal plane
parallel

Check

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Task 4

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Divergent light enters the eye from objects close to the eye. The myopic eye can image near objects.

○ True ○ False

Check

What option is there for the myopic person to correct their eye defect for seeing distant objects?

With the help of glasses with convex lenses ("plus lenses") for far vision, the short-sighted person can correct their eye defect.

Myopia cannot be corrected.

With the help of glasses with concave lenses ("minus lenses") for far vision, the short-sighted person can correct their eye defect.

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