Presbyopia in old age and its correction

The aim of the experiment is to demonstrate on an eye model how presbyopia can be corrected.

Physics > Light & Optics > Optical devices & lenses

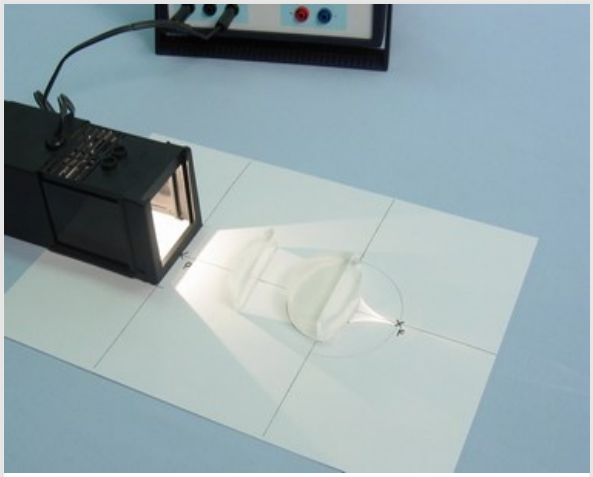
Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6331eef0e9165200034699b1

Teacher information

Application



Presbyopia and its correction

Due to the normal ageing process of the eyes, vision in the near range usually deteriorates from the mid-40s onwards. This is called presbyopia. Presbyopia cannot be treated effectively, but the visual defect can be minimised by correcting it with glasses, for example. Presbyopia is caused by the fact that the lens of the eye becomes more rigid with age and accommodation decreases.

Some diseases, such as diabetes, cardiovascular diseases or multiple sclerosis, favour presbyopia.

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Other teacher information (1/5)

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Prior knowledge

Students should have knowledge of the light path in the human eye and know the concept of accommodation.

Principle

Strongly divergent incident light can no longer be combined on the retina, but only behind it. This means that objects close to the eye are no longer in focus.

Other teacher information (2/5)

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Learning objective

With this experiment, the students are to repeat their knowledge about the light path in the human eye and about the accommodation of the eye for near and distant objects. From the observation of insufficient accommodation for divergent light incident on an eye model and thus the resulting need for correction with the aid of a convex lens, they should draw conclusions regarding the appearance of presbyopia.

Tasks

The aim of the experiment is to demonstrate on an eye model how presbyopia can be corrected.

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Other teacher information (3/5)

Notes

The experiment is demanding in terms of skills and abilities, especially due to the necessary abstraction from the plane model to the real eye.

The experiment provides an understanding of why older people very often need glasses for near vision. This makes it possible to differentiate between short-sightedness and long-sightedness, which are caused by a defective structure of the eye.

Presbyopia is due to hardening of the lens of the eye and thus to a decrease in the ability to accommodate in old age. As a result, older people can no longer see close objects sharply on the retina, the focal length of the eye lens can no longer become small enough. This can be remedied by glasses with a convex lens, which are only worn for close-up vision.

Other teacher information (4/5)

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Notes on set-up and procedure

If the experiments on the functioning of the eye and defective vision have already been the subject of the students' experimental work, no major difficulties are to be expected with regard to setting up and carrying out the experiment. The accommodation of the eye to objects close to the eye is simulated by adding the narrow plano-convex lens. Care must be taken to ensure that the flat surface of this lens lies exactly against the semicircular convex lens acting as the eye lens and that the adjusted position of the eye lens does not change in the process. Furthermore, it is important that the collection point of the incident light is always on the optical axis in all partial experiments. This can easily be achieved by positioning the light box symmetrically to the optical axis and the additional lenses placed in the light path. The marking of the outlines of the lenses and the focal points is for subsequent discussion.

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Other teacher information (5/5)

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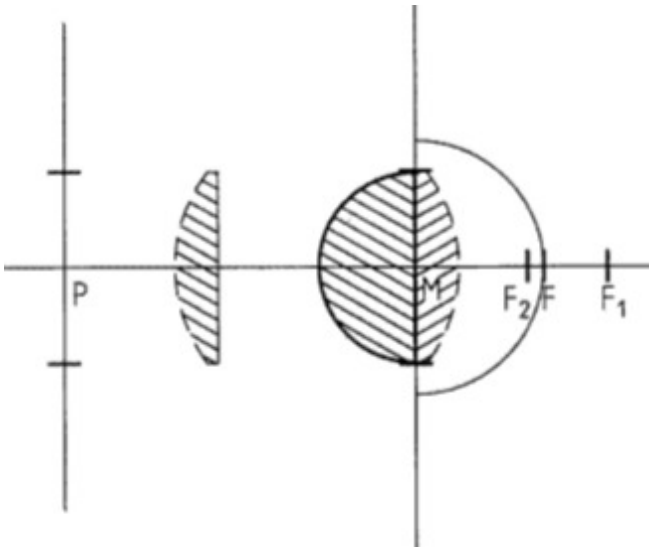
Note on the results

The students' notes should roughly correspond to those in the figure on the right.



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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Most people need glasses to read from the age of 50 at the latest. The reason for this is the so-called presbyopia. With increasing age, the lens in the eye becomes more rigid and accommodation decreases. As a result, older people can no longer image objects on the retina, but the focal point is behind the retina. This results in blurred vision at close range.

Picture of reading glasses

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Task

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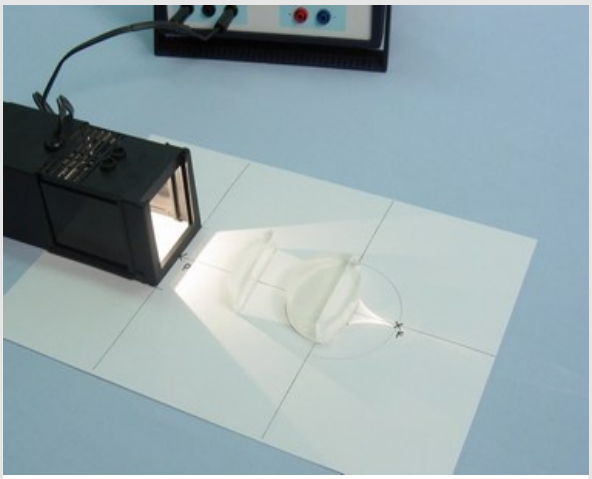

Experimental setup

What is presbyopia?

- Use an eye model to examine the measures that can be taken to correct presbyopia.

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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	2
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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Additional equipment

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

Set-up (1/2)

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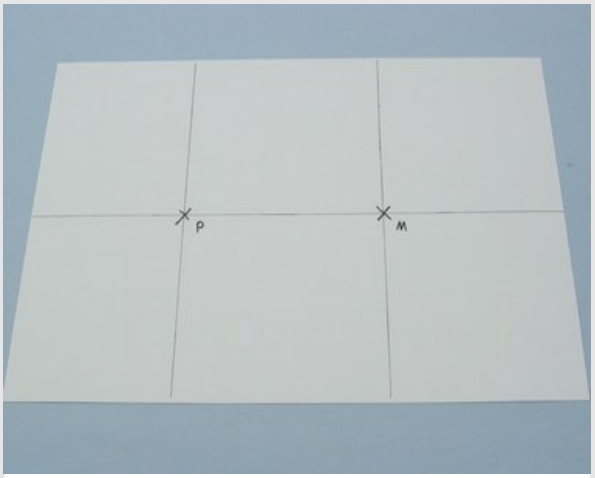
Attention!

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 as shown in the illustration.
- At a distance of 10 cm and 21 cm from the right edge, draw a right-angled cross of lines (the intersection of the lines is M resp. P) and at a distance of 3 cm from each M resp. P one mark on each of the vertical lines.



Preparation

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Set-up (2/2)

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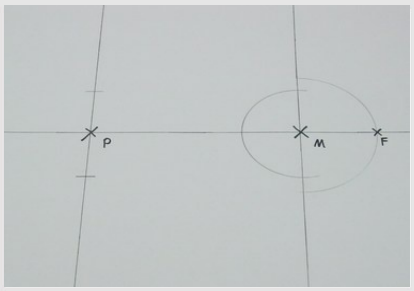
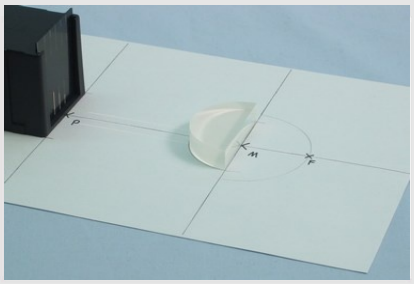
- Draw a semicircle around M with a radius of 3 cm.
- Draw a second semicircle around M with a radius of 4 cm. Let the point of intersection with the optical axis be F. This semicircle represents the retina in your eye model.
- Place the semicircular convex lens with the flat surface exactly inside the smaller semicircle.

  This lens represents the lens of the eye in your model.
- Insert the triple slit diaphragm into the light box on the lens side and set up the light box according to the illustration.





Procedure (1/3)

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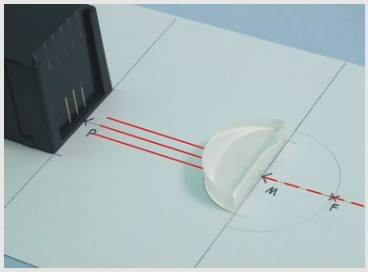

1. Seeing distant objects

- Connect the light box to the power supply unit (12 V ~).
- 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. Carefully mark the outline of the convex lens without moving it.
- Observe the path of the parallel light after it has passed through the semicircular convex lens, in particular the position of the focal point. Write down your observations.

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Procedure (2/3)

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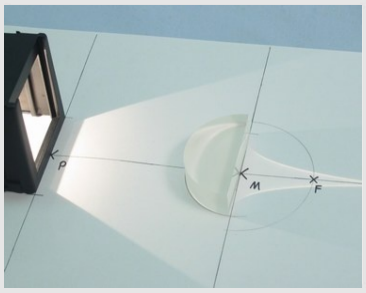
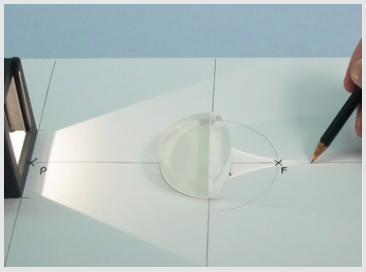




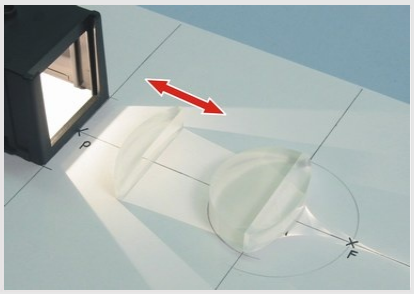
2. Seeing close objects

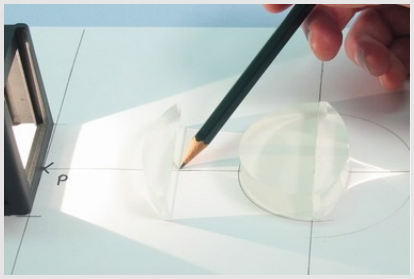
- Turn the light box 180° and remove the diaphragm so that the divergent light now falls on the curved side of the lens.
- Move the light box up to the vertical line (point P), whereby it should stand within the markings. Describe the course of the light behind the lens.
- Place the narrow plano-convex lens against the flat surface of the eye lens. In this case, mark the outlines of the lenses.
- Observe the change in the course of the light and mark the approximate tip of the light cone. Label it with F_1. Write down your observations.

Procedure (3/3)

PHYWE

- Place the second plano-convex lens between the light box and the eye lens.
- Describe the course of the light. Mark the tip of the light cone with F_2.
- Move this plano-convex lens a little. On which line can you move the point F_2embarrassed? Write down your observations.
- Switch off the power supply and remove the light box and the model body from the paper.





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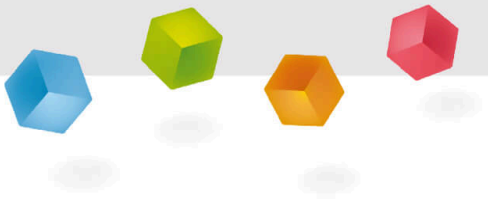

Report

Task 1

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10°

Compare your observations of the course of parallel or divergent light when it strikes a semicircular lens. What do they have in common?

- ○ The light incident parallel or divergent on the semicircular lens is reflected and collected as it passes through.
- ○ The light incident parallel or divergent on the semicircular lens is refracted and collected as it passes through.
- ○ The light incident parallel or divergent on the semicircular lens is refracted and scattered as it passes through.

Check

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Task 2

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10°

Almost parallel light emanates from object points far away from the eye. Formulate a statement about the course of light in the human eye for distant objects.

The [ ] incident light is [ ] and focused [ ] the focal point.F_1 [ ], which lies [ ] the retinal plane (behind point [ ]).

divergent | into | F | unites | behind | gathered

Check

Task 3

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What changes when the lens illuminated with divergent light is supplemented by an additional plano-convex lens?

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

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Task 4

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Image of a human eye

Divergent light enters the eye from objects close to the eye. The eye then changes the shape (diameter) of the lens of the eye and thus its focal length to match the position of the object.

○ True ○ False

Check

Task 5

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With age, the adaptability (accommodation ability) of the human eye for near objects (divergent incident light) generally decreases. What is the effect of this phenomenon called presbyopia?

Fill in the missing words.

Strongly [ ] incident light can no longer be united [ ] the retina, but only [ ] it (focal point F_1). This means that objects close to the eye are no longer [ ].

Check

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Task 6

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What is the purpose of glasses with convex lenses (opticians call them plus lenses) for older people? When are they worn? Drag the words into the correct boxes!

With the help of glasses with _____, the _____ of divergent incident light can be shifted to the _____, the image of _____ objects is sharp again.

For objects _____ from the eye, the eye's ability to accommodate is still sufficient, so the glasses only need to be worn for _____ vision.

near
retinal plane
far
intersection
convex lenses
near

Check

Slide	Score / Total
Slide 20: Commonality of the light path	0/1
Slide 21: Course of the light with distant objects	0/6
Slide 22: Supplement with plano-convex lens	0/1
Slide 23: Adaptation of the subject matter	0/1
Slide 24: Effects of presbyopia	0/4
Slide 25: Glasses with convex lenses	0/6

Total 0 / 19

Solutions Repeat

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