Light path and focal length of a concave lens

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/5f4e5c4938db8d0003265980

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Teacher information

Application

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single-lens imaging

We all use optical devices every day. These are mobile phone cameras, cameras, microscopes, binoculars and many, many more.

They all use lenses to enable the imaging of objects. Often these are combinations of convex and concave lenses.

This experiment deals with the imaging properties of concave lenses and thus strengthens the understanding of optical devices.

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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 concepts of diffraction and refraction.

Scientific principle

In connection with the experiments on the refraction of light, this experiment is of particular importance. The knowledge of the law of refraction is consolidated and transferred to a new subject. The experiments on the refraction of light on concave lenses serve to consolidate the knowledge and experimental skills gained in the experiments on convex lenses.

Other teacher information (2/4)

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Learning objective

The aim of this experiment is to observe the course of light as it passes through concave lenses and to determine the focal point and thus the focal length using the known methods. On the other hand, however, the position of the (virtual) focal point in front of the lens reveals a significant difference to convex lenses and thus prepares the introduction of the term "virtual image".

Tasks

Examination of the course of light through a plano-concave lens and determination of the focal length.

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Other teacher information (3/4)

The term "diverging lenses" is commonly used for lenses that are thicker at the edges than in the centre. However, the condition under which this statement is correct is very often neglected. Concave air-filled lenses in water - i.e. diverging lenses starting from the outer shape - have a collecting effect.

Correspondingly, convex air-filled lenses in water - i.e. convergent lenses starting from the outer shape - have a diverging effect.

Other teacher information (4/4)

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Instructions for construction and implementation

Care must be taken to ensure that the adjustment of the concave lens (flat surface at the vertical of the line cross, unbroken course of a light beam incident along the optical axis) is carried out very carefully by the student in order to achieve a clear and convincing experimental result.

If necessary, difficulties for the students could arise from the fact that a virtual focal point occurs in the concave lens as in the domed mirror. This means that a rearward extension of the refracted, diverging light bundles must be made.

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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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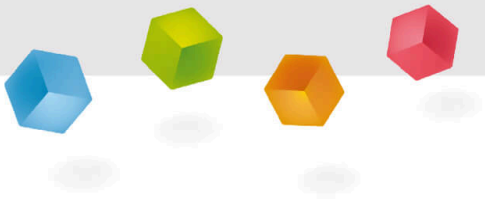

Student Information

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Motivation

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Binoculars

Optical devices:

We use binoculars, mobile phone cameras or microscopes frequently, if not daily, without thinking about what is actually inside.

In optical devices these are usually combinations of different lenses with different optical properties. One of these lenses and its imaging properties will be explained in this experiment.

Tasks

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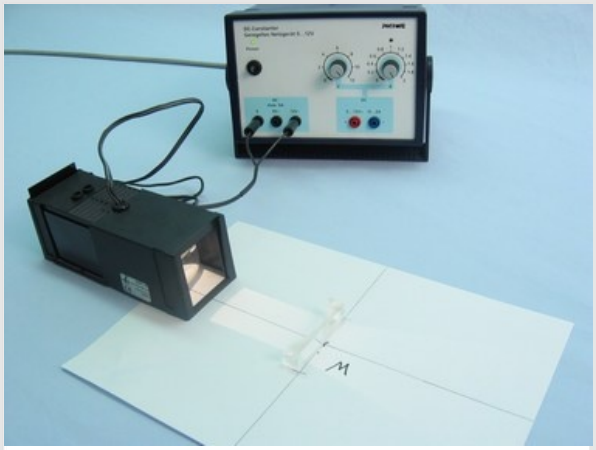

Experiment set-up

What distinguishes concave lenses from convex lenses?

1. Examine the course of light through a plano-concave lens and determine the focal length.

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Equipment

Position	Material	Item No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Block, planoconcave lens,fl-100mm	09810-05	1
3	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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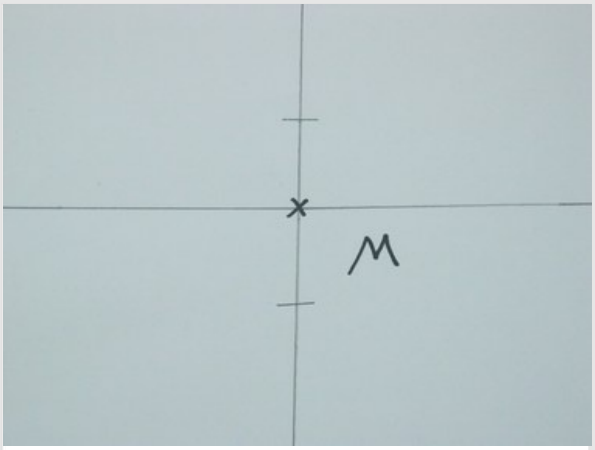
Additional equipment

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

Set-up (1/2)



Production of the line cross

Look out!

Make sure that in all experiments with the flat surface the lens is exactly on the vertical line of the line cross and that the model body does not change its position when moving the light box.

1. course of the light through a plano-convex lens.

Draw a right-angled line cross in the middle of a sheet of paper. The point of intersection of the lines is *M*. Draw in each 3 cm distance from *M* one mark on each vertical line.

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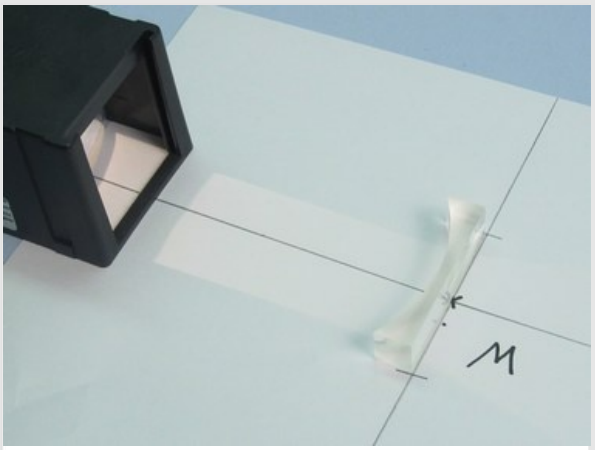
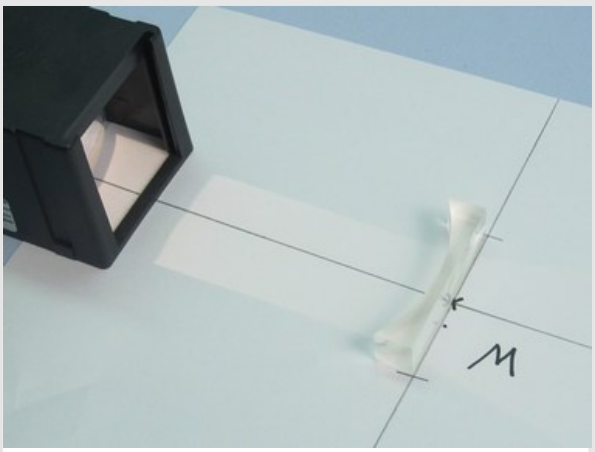
Set-up (2/2)



Setting up the light box

- Connect the light box to the power supply unit (12 V ~)
- Place the light box with the lens side, but without the aperture, on the edge of the sheet.
- Place the plano concave lens (roughened side down) with the flat surface exactly on the vertical line of the line cross within the two marks.

Procedure (1/5)



Illumination of a concave lens

- Observe the course of the parallel light as it passes through the lens.

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Procedure (2/5)

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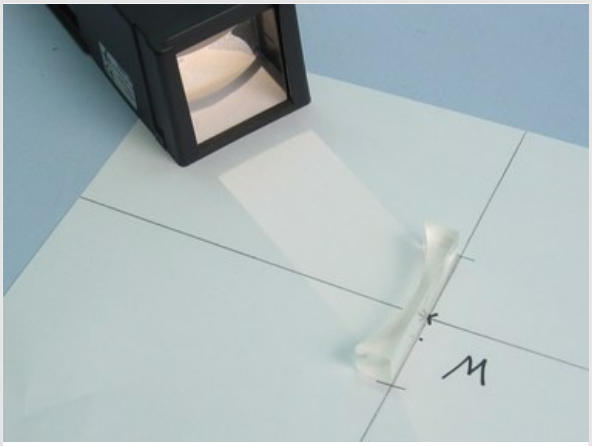

Lateral incidence of light into a concave lens

- Now move the light box to the positions according to the illustrations and observe the course of the light again.
- Note your observations in the protocol.

Implementation (3/5)

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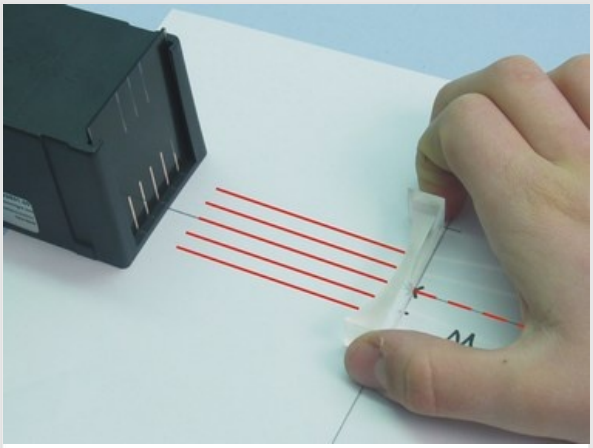

Using the light box with five slit diaphragm

- Insert the five slit diaphragm into the light box on the lens side and place it at a distance of about 10 cm from the inwardly curved (concave) surface of the model body.
- The central light beam should be incident exactly along the optical axis. If it is not along the optical axis, carefully move the lens slightly along the vertical line.

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Procedure (4/5)

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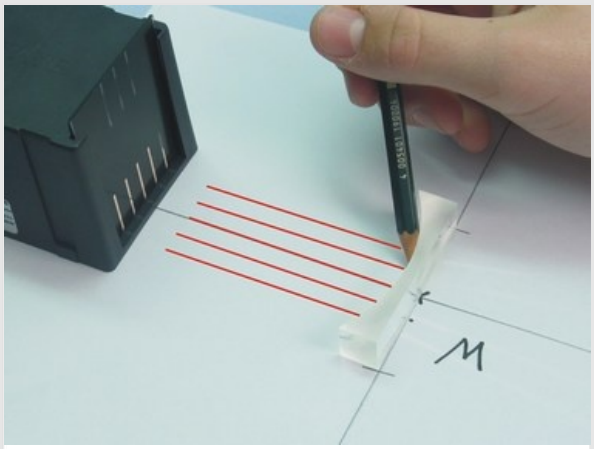

Marking the position of the lens

- Mark the outlines of the lens with a thin pencil stroke.
- Describe the course of the narrow light beams as they pass through the lens, in particular the light path within the lens in the protocol.

Procedure (5/5)

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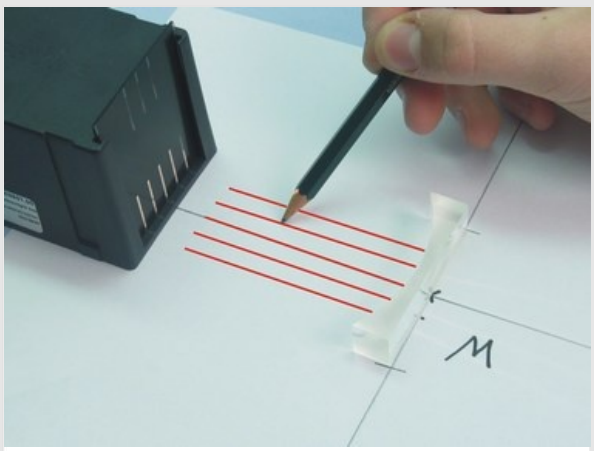

Sketch of the beam path

- Always mark with two crosses the course of the light beams above and below the optical axis before and after passing through the lens.
- Switch off the power supply and remove the light box and model body from the paper.
- Connect the matching crosses so that the course of the light beams before and after passing through the lens and, after appropriate connection, also within the lens is visible.

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Report

Observation

Write down your observations.

a) Observation of the course of light without aperture:
The light incident in parallel on a concave lens is _____ by the lens and diverges behind the lens, it diverges.

refracted
to the optical axis
refracted twice

b) Observation of the course of light with a five slit diaphragm:
The narrow beams of light incident on a concave lens parallel _____ are _____ as they pass through the glass of the lens and diverge behind the lens.

Check

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Task 1

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Using your observations, describe how parallel light behaves when incident on a plano-concave lens.

Parallel to the _____, _____ incident on a _____ run outwards after the _____, they _____.

diverge
concave lens
light beams
fraction
optical axis

Check

Task 2

PHYWE

Extend the refracted light rays with a coloured pencil until they intersect. What can you determine about the position of the intersection?

The _____ of the rear extensions of the _____ is in front of the _____ (on the side of the light incidence) on the _____.

concave lens
intersection
optical axis
refracted light beams

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Task 3

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Designate the point of intersection of the refracted rays with F'.

Measure the distance of the point F' (the focal point) from the center M and enter the value here.

$\overline{MF'}$ = _____ cm

Note: Since the lens can no longer be considered a thin lens, the point of intersection of the outer rays is slightly closer to the lens than that of the inner rays. For the distance $\overline{MF'}$ the average value should be given.

Check

Task 4

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Why are light bundles incident on a concave lens along the optical axis not refracted?

For a light beam incident on a concave lens along the _____, the _____ and thus the _____ is 0°, there is _____.

angle of refraction
optical axis
angle of incidence
no refraction

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Task 5

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What distinguishes concave lenses from convex lenses?

In contrast to convex lenses, parallel incident light is not _____ at a concave lens, but _____. The (_____) focal point of concave lenses is _____ of the lens, whereas with convex lenses the (_____) focal point is _____ the lens (viewed from the side of the light incidence). Lenses that have this scattering property are also called _____.

collected
virtual
diffusing lenses
real
scattered
in front
behind

Check

Slide	Score / Total
Slide 21: Light pattern	0/3
Slide 22: Parallel light on plano-concave lens	0/5
Slide 23: Position of the intersection point	0/4
Slide 24: Point of intersection of the refracted rays	0/1
Slide 25: Light beam along the optical axis	0/4
Slide 26: Difference between concave and convex lenses	0/7

Total amount 0 / 24

Solutions Repeat

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