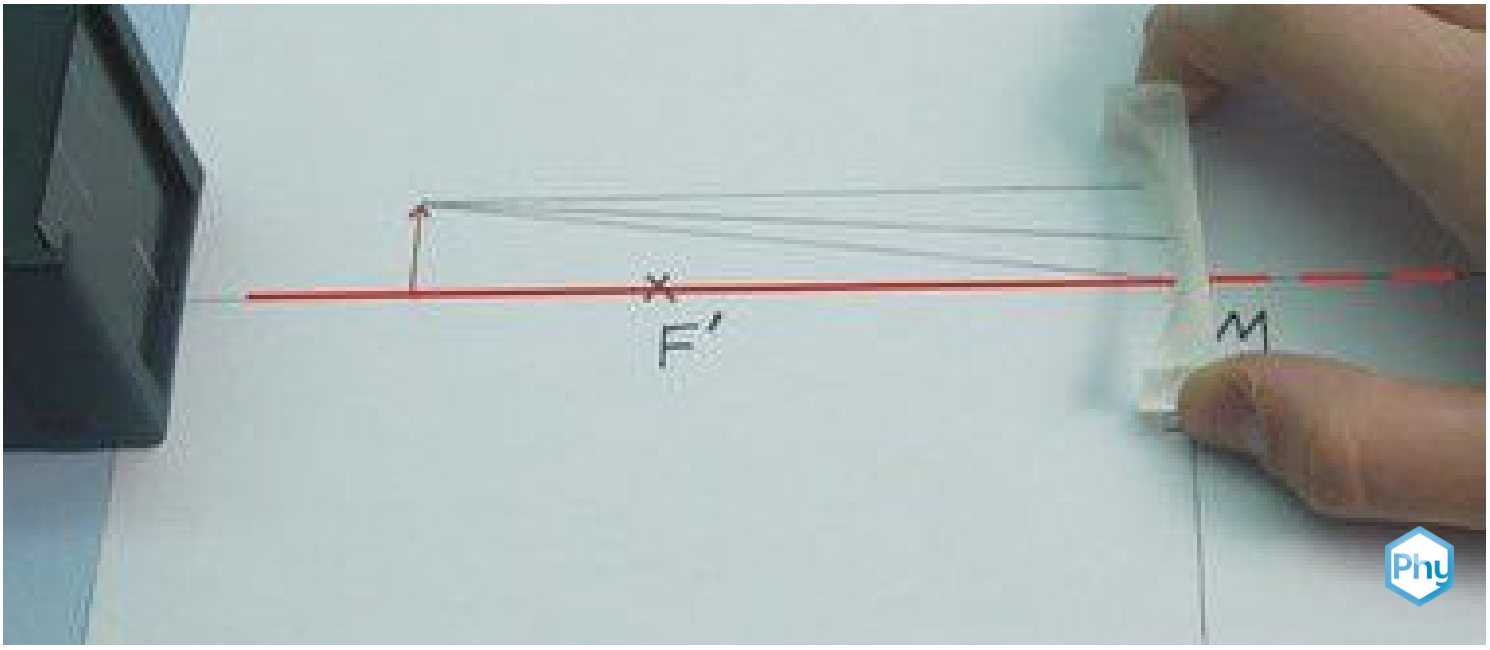
Image construction on concave lenses



The task of the experiment is to record the experimental determination of the intersection of selected light beams incident on a plano-concave lens and the resulting possibility of image construction.

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/616d5c2faeb0ac0003430b2f

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Teacher information

Application

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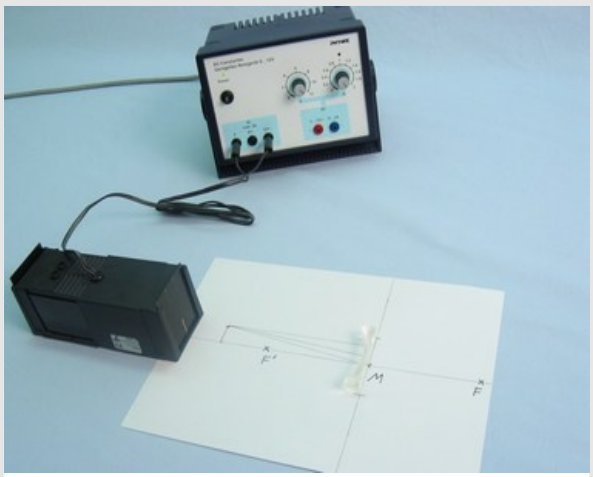

Image construction on concave lenses

A concave lens, also called a diverging lens, is a lens in which the center thickness is thinner than the edge thickness. If the light rays fall on the lens parallel to the axis, they diverge after refraction and appear to come from a virtual focal point located on the side of the incident light.

Concave lenses are used, for example, optical instruments or to correct myopia.

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Other teacher information (1/4)

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Previous

Students should have previously learned the basics of straight line propagation, reflection and refraction of light, as well as the construction of pixels.

Principle

If the object is outside the distance $\overline{MF}$ in front of the plano-concave lens, then the image is at a shorter distance (within the focal length) and on the same side as the object. The image is reduced in size and upright. It is an apparent (virtual) image.

Other teacher information (2/4)

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Learning

In the evaluation, the possibility of image construction with the help of the backward extensions of the light rays is revealed to the student. This provides suitable starting points for a discussion about the role of mathematical tools in physical knowledge. Last but not least, the confirmation of the lens equation becomes clear by means of an example.

Tasks

The task of the experiment is to record the experimental determination of the intersection of selected light beams incident on a plano-concave lens and the resulting possibility of image construction.

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Other teacher information (3/4)

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Note

The experiment is very demanding in terms of the experimental skills required and the knowledge gained with it. No real image results, because the intersection of the backward extended refracted light beams lies in front of the plano-concave lens.

This gives the teacher the opportunity to explain to the student the nature of virtual images and to deepen his knowledge of virtual images on the plane and convex mirror.

Other teacher information (4/4)

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Notes on structure and implementation

Care must be taken to ensure that the adjustment of the lens (plane surface lies at the perpendicular to the line cross, unbroken course of a narrow beam of light incident along the optical axis) is carried out very carefully by the student in order to obtain a clear and reproducible experimental result.

To facilitate the correct setting of the light box, it is recommended to draw guide lines (starting from the tip of the object arrow) before the experiment.

During refraction at the plano-concave lens, even the narrow light bundles are somewhat scattered. To mark the light path behind the lens, the center of the respective light bundle should therefore be selected.

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Safety instructions

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

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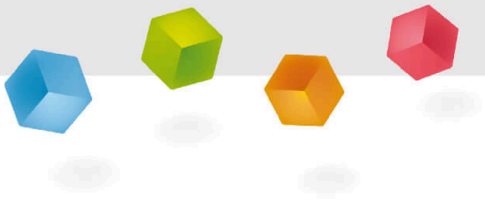

Student Information

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Motivation

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A concave lens, also called a diverging lens, is a lens that is curved inwards. They are used in many optical instruments but also, for example, to correct myopia. In myopic people, the image is not formed on the retina, but in front of it. With the help of a diverging lens, this can be corrected and the visual performance improved.

Glasses as concave lens

Task

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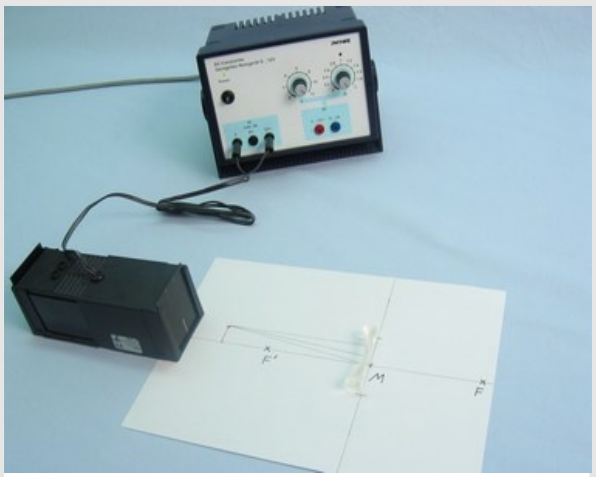

Test setup

Do concave lenses also produce images?

- Investigate image formation through a concave lens using selected light beams.

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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 material

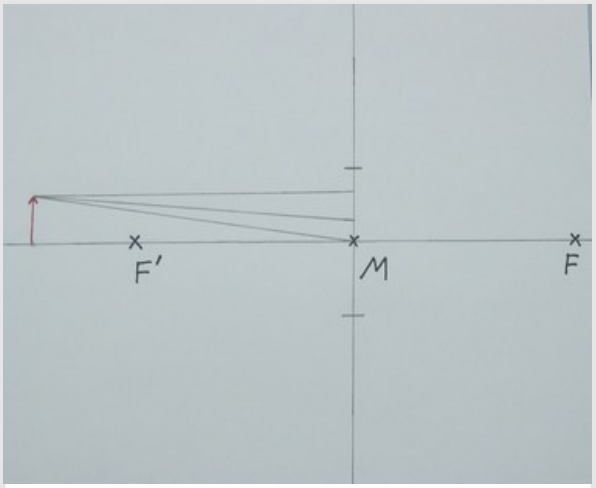
Position	Material	Quantity
1	Ruler (approx. 30cm)	1
2	White paper (DIN A4)	1

Set-up (1/3)

Attention!

Make sure that the plano-concave lens is positioned with its flat surface exactly on the vertical line of the line cross and that its adjusted position is not changed when the light box is moved.

- Prepare the sheet of paper according to the illustration.
- Construct a right-angled line cross in the right third. Let the intersection of the lines be M. Draw at a distance of 3 cm from Mone mark each on the vertical line.



Preparation

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Set-up (2/3)

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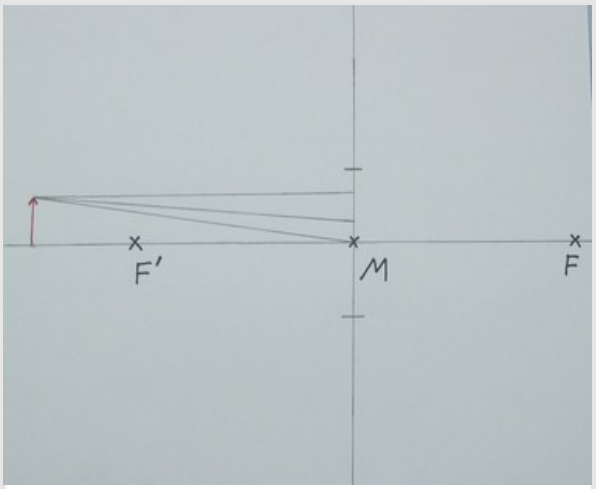
- Mark at a distance of 9.5 cm to the left and right of the $M$the points $F$and F' on the optical axis.
- Draw at a distance of 14 cm to the left of the point M with a red crayon, draw a vertical arrow 2 cm long on the optical axis and mark it with G.
- Draw the following guide lines from the tip of the object arrow $G$to the center line:

  - a parallel to the optical axis,

  - a line in the direction of the right focal point F,



Preparation

Set-up (3/3)

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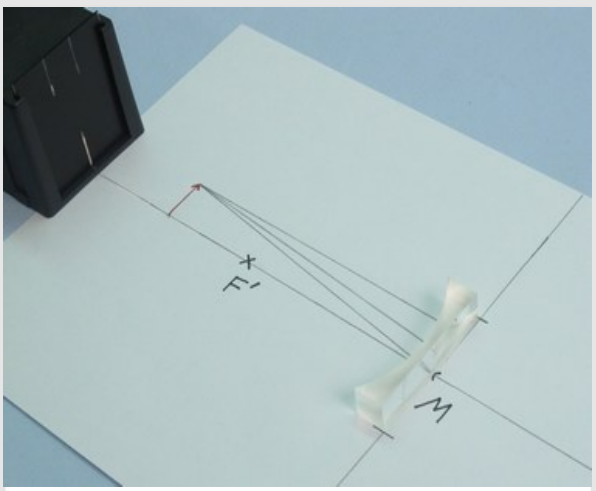
- Place the plano-concave lens (roughened side down) with the planar surface exactly at the vertical line of the line cross within the two markings.
- Insert the slit diaphragm into the light box on the lens side and place it at the edge of the sheet.



Placement of the plano-concave lens

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Procedure (1/2)

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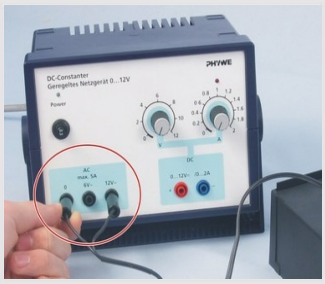
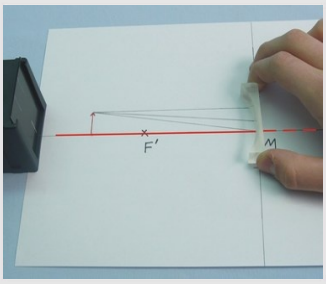
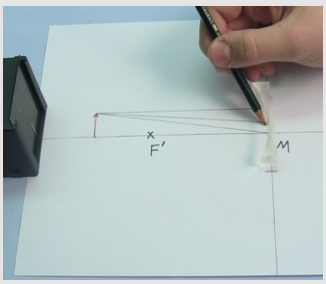
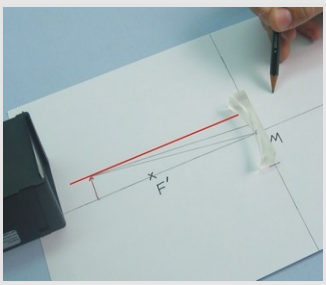
- Connect the light box to the power supply (12 V ~).
- Adjust your experimental setup so that the narrow beam of light incident along the optical axis continues along the optical axis after passing through the lens.
- Mark the outline of the lens with a thin pencil.
- Let the light beam fall parallel to the optical axis along the auxiliary line onto the lens and mark the course of the light beam behind the lens.









Procedure (2/2)

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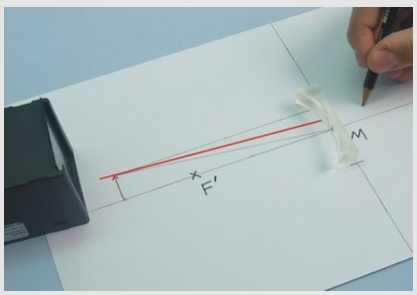
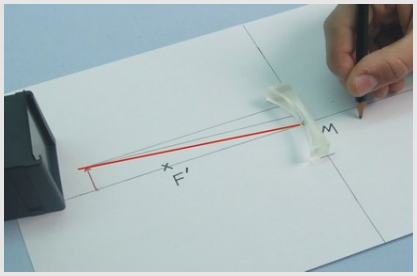
- Let the light beam along the auxiliary line in the direction of the focal point. $F$and again mark the course of the light beam.
- Finally, let the light beam pass through the center point along the auxiliary line. $M$and mark the course again.
- Turn off the power supply and remove the light box and the plano-concave lens from the paper.
- Connect the marks that belong together so that the course of the light beams becomes visible.





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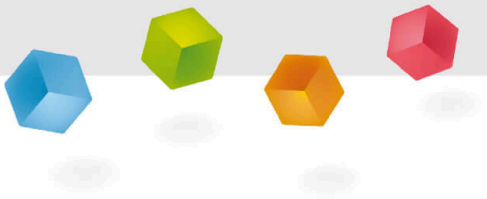

Report

Task 1

10° PHYWE

Evaluate the truth of the following two statements:

The narrow light beams diverge after refraction by the concave lens.

○ True ○ False

Check

The intersection of the back extensions is in front of the concave lens and above the optical axis.

○ True ○ False

Check

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Task 2

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10°

The point of intersection of the three light rays is the image of the tip of the object arrow. Draw the perpendicular connection from this intersection to the optical axis and label this arrow with B.

Fill in the blanks that show the characteristics of the picture.

If the object is _____ the distance $\overline{MF}$ (focal length f') in front of the plano-concave lens, then the image is at a _____ distance (_____ the focal length) and on the same side as the object. The image is _____ and upright. It is an apparent (_____) image.

- within
- virtual
- outside
- reduced in size
- shorter

Check

Task 3

PHYWE

Do concave lenses also produce images?

- No, the images on concave lenses are behind the lens. Therefore, as with the plane mirror, they are real images.
- Yes, the images at concave lenses are in front of the lens. Therefore, as with the plane mirror, they are real images.
- Yes, the images on concave lenses are in front of the lens. Therefore, as with the plane mirror, they are apparent (virtual) images.

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Additional task

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For the image formation at a concave lens the equation is valid:

$$\frac{1}{f} = \frac{1}{g} + \frac{1}{b}$$

where f is the focal length, g is the object distance and b is the image distance. Check your measurement results with this equation.

Note: This equation is also called the lens grinding formula and is used, for example, in a simplified form to calculate diverging lenses.

Glasses as an example of a diverging lens

Slide	Score / Total
Slide 19: Multiple tasks	0/2
Slide 20: Properties of the image	0/5
Slide 21: Images on concave lenses	0/1

Total 0 / 8

Solutions Repeat

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