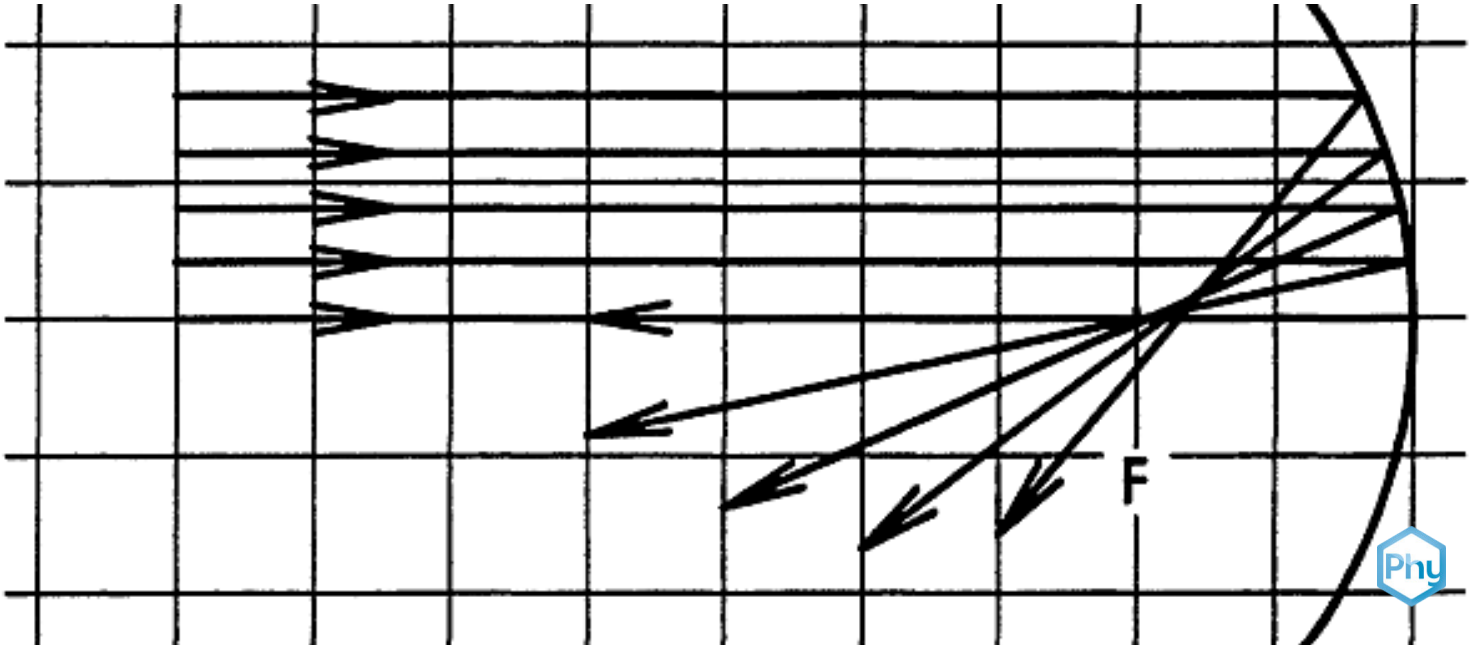
Aberrations with a concave mirror (catacaustics)



Physics > Light & Optics > Reflection & refraction of light

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/642827335e30a7000275ea16

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Teacher information

Application

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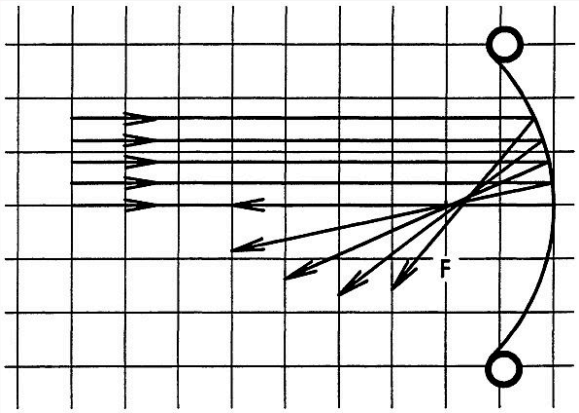

Experimental set-up:

Concave mirror

Light propagates in a straight line. If a light beam hits a reflecting object, the light beam also spreads out in a straight line from there.

A concave mirror can only sharply reproduce the incoming rays to a certain extent. If the rays are too far away from the optical axis, they can no longer be perceived.

The experiment is intended to show that it is only possible to work properly with such a mirror at a certain distance.

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Other teacher information (1/2)

Prior knowledge

The students need theoretical knowledge about the straight-line, ray-shaped propagation of light and that objects reflect light rays.

Furthermore, students should know the basics about a concave mirror and its refection behaviour.

Principle

It is to be shown that aberrations occur at the concave mirror if the light rays do not hit the mirror close to the axis.

Other teacher information (1/2)

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Other teacher information (2/2)

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Learning objective

The students should gain knowledge about the principles of light reflection. Furthermore, they should realise that a concave mirror does not function as desired from every position.

Tasks

The students should observe how a concave mirror reflects the different incident rays. And understand that images on a concave mirror appear blurred or distorted when it is used disproportionately.

Additional teacher information

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Note

If the concept of catacaustics is to be dealt with, then one can sketch the envelope curve for the reflected rays. This envelope curve can be obtained even more elegantly if the adhesive luminaire is used last without a diaphragm and the wide parallel light beam is shifted up and down parallel to the optical axis.

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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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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	Diaphragm w. holder, magnet held	08270-10	2
4	Concave/convex mirror,magnet held	08270-12	1
5	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
6	G-clamp	02014-00	2

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Set-up and Procedure (1/3)

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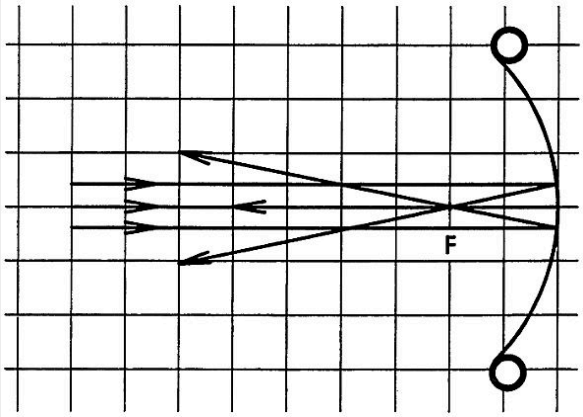

Fig.1:

Concave mirror with 3-slit aperture

- Draw optical axis
- Draw an arc of a circle with radius r = 200 mm on the board using a template or compass.
- Set mirror on circular arc
- Position the luminaire with the 3-slit aperture so that the central light beam runs along the optical axis; readjust the mirror if necessary; mark the focal point.

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Set-up and Procedure (2/3)

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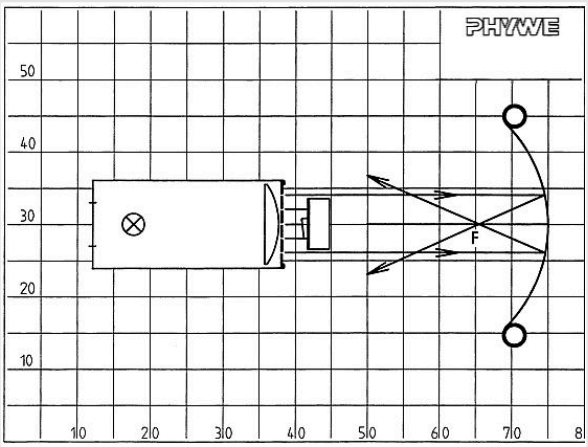

Fig.2:

Concave mirror with 5-slit aperture

- Replace 3-slit aperture with 5-slit aperture
- Use apertures with a holder to alternately block the two parallel beams further away from the axis or the parallel beams closer to the axis.
- The illustration shows the course of the light rays further away from the axis

Set-up and Procedure (3/3)

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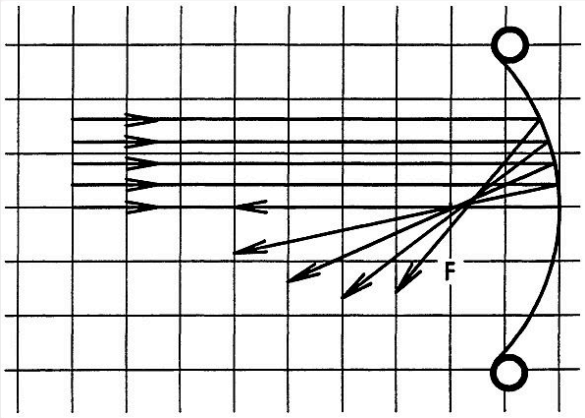

Fig.3:

Concave mirror with 5-slit aperture

- Shift the luminaire downwards and upwards so that the parallel beams are partly very far away from the axis.
- Observe reflected rays and trace some as far as possible if necessary
- Remove mirror and luminaire and complete beam paths

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Report

Task 1

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Write down your observations on the different experimental set-ups.
Complete the ray traces of the third set-up by drawing.

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Task 2

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Fill in the blanks!

Only parallel rays _____ the axis are reflected by the concave mirror in such a way that they intersect at a point on the _____ axis, the _____, after reflection at the concave mirror. Parallel rays that are far away from the axis run after _____ at the concave mirror in such a way that they intersect the optical axis _____ to the apex of the mirror the further they are from the optical axis.

near | optical | closer | reflection | focal point

Check

Task 3

PHYWE

Fill in the blanks!

Images on a concave mirror become _____ or distorted if the object is relatively _____ in relation to the _____ of the mirror. For then _____ rays emanating from object points are partly _____ rays.

blurred | radius of curvature | axis-distant | axis-parallel | large

Check

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