Projected image with a concave mirror

Physics > Light & Optics > Reflection & refraction of light

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/62dba6d0c4f747000347b210

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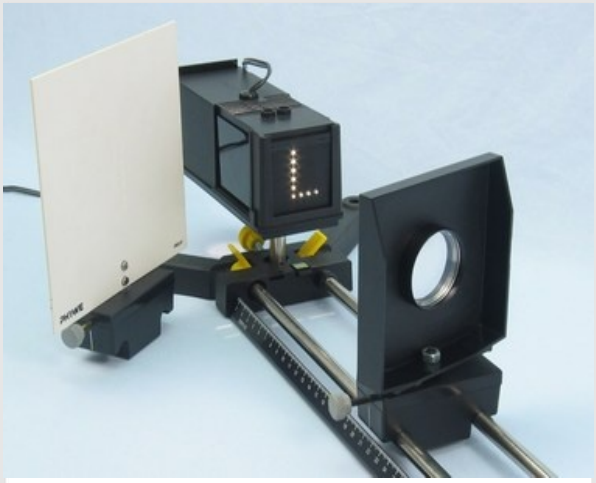
Teacher information

Application



Experimental setup

Concave mirrors focus the light onto a focal point and can produce a magnified mirror image, provided they are at the right distance from the object. Many concave mirrors can be found in everyday life: as cosmetic mirrors in the bathroom or as burning mirrors for solar rays that focus the light in a solar power plant.

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Other teacher information (1/4)

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Principle

Light rays are concentrated on a focal point by a concave mirror that is curved concavely. They therefore produce reduced, enlarged and/or inverted images depending on how far away the image is viewed.

Learning objective

The pupils should observe the mirror effect of a concave mirror and correctly classify the relation between focal length and object width with the resulting images. Furthermore, the terms *virtual image* and *real image* shoul be clarified.

Other teacher information (2/4)

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Task

1. The students move the screen so that the Perl-L image is sharply visible on the screen.
2. The resulting image width and object width are compared with focal length. The image on the screen is to be described and the results noted in a table.
3. The steps are repeated for different item widths and the results are entered in a table.

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Other teacher information (3/4)

This experiment is very demanding. Although it does not make any increased demands on the accuracy of the measurements, the recording of the individual cases for the image width and the properties of the image as a function of the object and focal length, the inequalities that occur and the large number of technical terms often cause difficulties for the pupils, as experience has shown.

This experiment could be facilitated by a division of labour: the students are divided into 4 groups and each group works on one of the cases given in the task. Afterwards, the results are exchanged and Table 1 is completed cooperatively. In this way, each group can complete its specific assignment carefully and without time pressure.

Other teacher information (4/4)

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Notes on set-up and procedure

- Due to the necessary tilting of the concave mirror, the image is somewhat laterally distorted. The teacher should make sure that the students turn the mirror only as far as necessary from its perpendicular position to the optical axis and set up the screen so that its surface is approximately perpendicular to the optical axis of the mirror.
- The case $g < f$ will initially cause more difficulties for the students as they try to catch the image with the screen, if the experiment is not used as a confirmation experiment. The teacher should in this case - after the students have encountered the problem of not getting an image on the screen - give the hint that the students have to look against the light path, i.e. in the direction of the concave mirror, to be able to see the image.

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Safety instructions

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

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Student information

Motivation

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Cosmetic mirror

Many concave mirrors can be found in everyday life: as cosmetic mirrors in the bathroom or as burning mirrors for solar rays that focus the light in a solar power plant. Concave mirrors focus the light onto a focal point and can produce a magnified mirror image, provided they are at the right distance from the object.

How do concave mirrors work?

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Equipment

Position	Material	Item No.	Quantity
1	Optical profile-bench for student experiments, l = 600 mm	08376-00	1
2	Light box, halogen 12V/20 W	09801-00	1
3	Bottom with stem for light box	09802-20	1
4	Concave/convex mirror with rod	09821-00	1
5	Slide mount for optical bench	09822-00	2
6	Screen, white, 150x150 mm	09826-00	1
7	Object -L-, glass bead	11609-00	1
8	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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Set-up (1/3)

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- Assemble the optical bench from the two tripod rods and the variable tripod foot and place the scale on the front tripod rod.
- Place the base with stem under the light box.

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Set-up (2/3)

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- Clamp the light box in the left part of the tripod base so that the lens side faces away from the optical bench.
- Slide an opaque shade in front of the lens and the Perl-L into the shaft at the other end of the luminaire.

Set-up (3/3)

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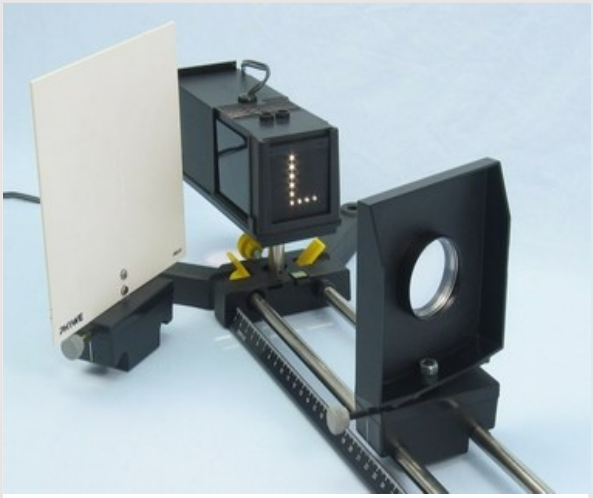

Experimental setup

- Complete the experimental set-up by placing the concave mirror and the screen as shown in the illustration.
- Note: The concave mirror is positioned approximately at an angle on the optical bench so that the light reflected from it can strike the screen.

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Procedure (1/3)

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Power supply unit

- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Select the distance of the concave mirror from the Perl-L, i.e. the object width g so that $g = 2f$. The mirror has the focal length $f = 100\,\mathrm{mm}$.

Procedure (2/3)

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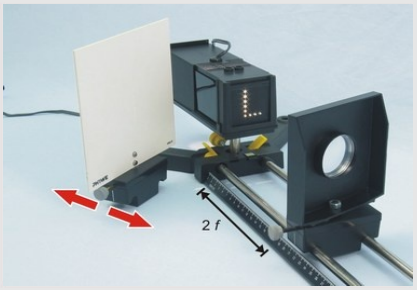
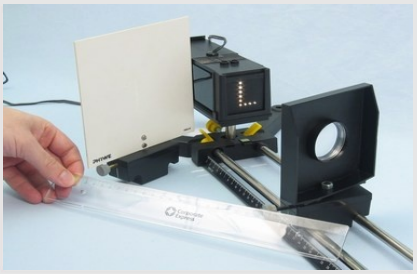
- Move the screen until the L is in focus on it.
- Measure the width of the picture with the ruler b and compare it with the focal length f; look at the picture.
- Enter the results in Table 1 in the section "Observations and measurement results". Use the words to indicate the 3 essential characteristics of the image: "upright" or "reversed"; "enlarged" or "reduced" or "equal-sized"; "real" or "virtual".





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Procedure (3/3)

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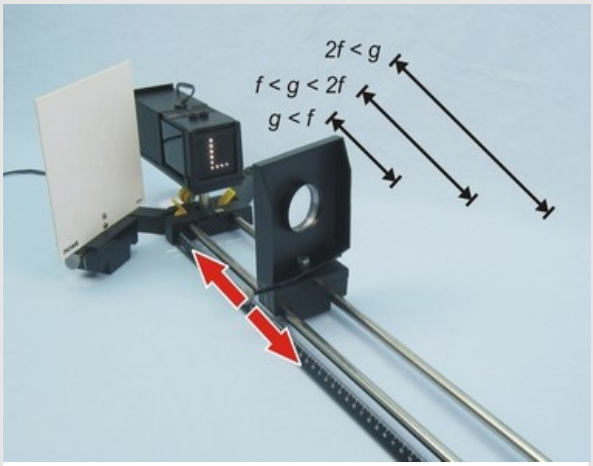

Shifting the screen on the optical bench

- Follow the same steps for $g > 2f$, $f < g < 2f$ and $g < f$. Write down your results.
- Switch off the power supply unit.

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Report

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Table 1

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Enter your measurements in the table.

Object Width	Image Width	Properties of the Image		
$g > 2f$		reversed		
$g = 2f$				real
$2f > g > f$			enlarged t	
$g < f$	negative			virtual

Task 1

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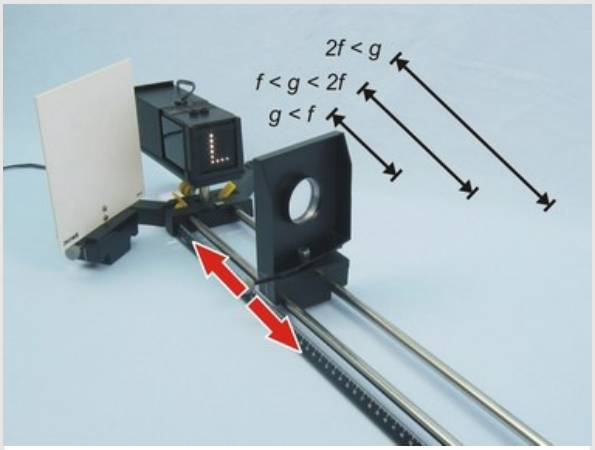
Under what condition does a concave mirror always generate a **real** image?

- $g < f$
- $g > f$
- $2f > g$

Check



Shifting the screen on the optical bench

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Task 2

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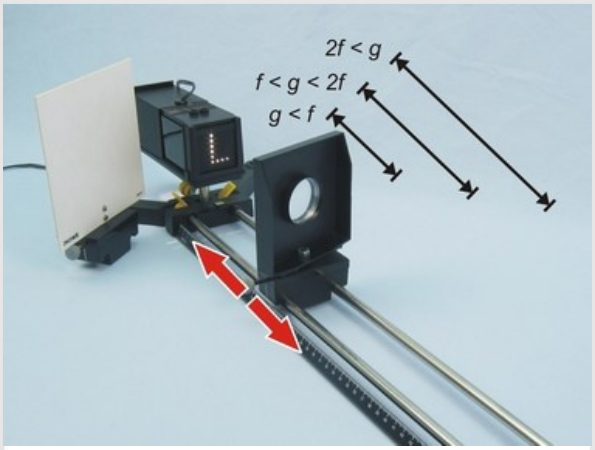
Under what condition does a concave mirror always generate a **virtual** image?

- $g > f$
- $2\,f > g$
- $g < f$

Check



Shifting the screen on the optical bench

Task 3

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What happens when the object is within the focal length of the concave mirror ($g = f$)?

- No image emerges. Or: The image lies in the infinite.
- A reversed picture emerges.
- The result is a reduced image.

Check

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Task 4

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What are applications of concave mirrors to create images?

- [ ] Burning mirrors for solar power plants
- [ ] Tube TV
- [ ] Reflecting telescope
- [ ] Traffic mirrors
- [ ] Dental mirror

Check

Task 5

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In everyday life there are many examples of hollow metal objects acting like concave mirrors, e.g. a brightly polished metal spoon. Look carefully into such a spoon and look at your reflection. What do you notice?

- [ ] Depending on how far away the spoon is held from the eyes, the different images are created, just like with the concave mirror.
- [ ] The images are distorted.
- [ ] A wider perspective is created.

Check

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