Determining the magnification of 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/62dbb5d8a52f910003dffb5a

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Teacher information

Application

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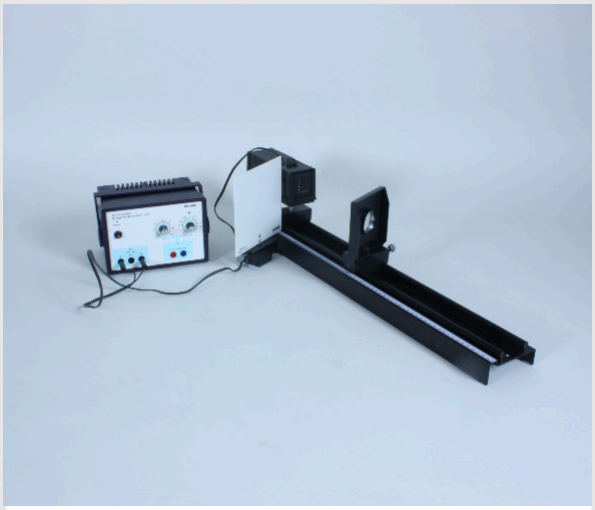

Experimental setup

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 students should observe the mirror effect of a concave mirror and explain the relationship between image size and image quality. B, item size G, Image width b and object width g.

Other teacher information (2/4)

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Task

1. The students place the shade in front of the lamp so that the light from the lamp passes close to the shade and the Perl-L image is sharply visible on the shade.
2. For a fixed object width of $g = 210\,\mathrm{mm}$the image width b, the object size G and the image size B measured and entered in a table.
3. For a larger object width, the values for g, b and B measured and entered in the table.
4. Now the shade is to be placed next to the luminaire and the corresponding measured values are to be determined and entered for 2 enlarged images.

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Other teacher information (3/4)

Obtaining the equation $A = B/G = b/g$(scale of reproduction) by theoretical means generally presents few difficulties. It is therefore advisable to use the experiment as a confirmation experiment. Then the students have sufficient goal orientation for the experiment and know from the outset that it is important to find the two quotients B/G and b/g by calculation and compare them after the 4 occurring variables have been determined experimentally.

If the values measured by the students result in quotients that differ greatly from each other, they should be re-measured if necessary. In order to estimate the relative error and to be able to discuss it easily with the students, it is advisable to measure the quotients $B/G : b/g$. (In the present example they have the amounts 1.05; 1.02; 1.04 - so with careful measurement the experiment yields good results).

Other teacher information (4/4)

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Notes on set-up and procedure

- With the available scale for the stand bench, it is possible to measure all 4 sizes. However, it is easier to measure if the scale is applied to the front stand rod and only the distances are measured with it. *g* and *b* be determined. Item size *G* and image size *B* can be measured more conveniently with an additional ruler. The teacher should make sure that the students turn the concave mirror only as far as necessary from its perpendicular position to the optical bench.
- Due to aberrations, the individual pearls of the pearl L may be in focus at different distances, especially at larger B. Therefore, it is appropriate to note that the L should be considered in focus when the near-axis parts of the image are in focus.
- If the students do not come up with this idea on their own, it is also advisable to point out that the picture width *b* must be measured from the centre of the image to the apex of the concave mirror.

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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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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?

Tasks

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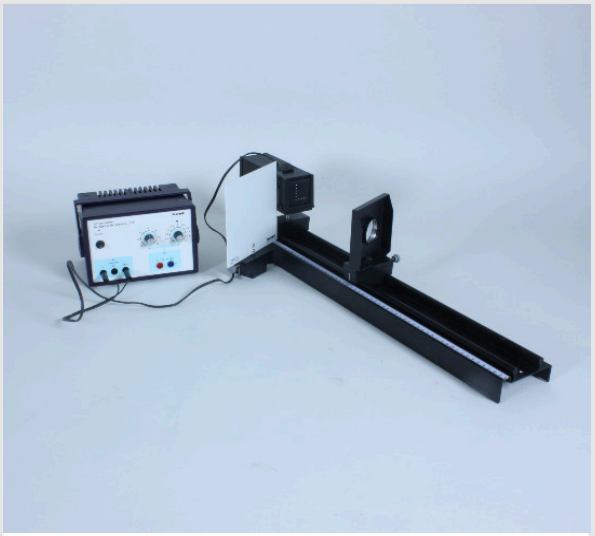

Experimental setup

1. Place the shade in front of the luminaire so that the light from the luminaire passes close to the shade and the Perl-L image is sharply visible on the shade.
2. For a fixed object width of $g = 210\,\mathrm{mm}$you measure the image width b, the object size G and the image size B and enter them in the table in the report.
3. By moving the mirror to the right, you increase the width of the object and then measure the values for g, b and B and enter them in the table.
4. Now place the shade next to the luminaire and determine the corresponding measured values for 2 enlarged pictures, which you also enter in the table.

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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.




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.


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Set-up (3/3)

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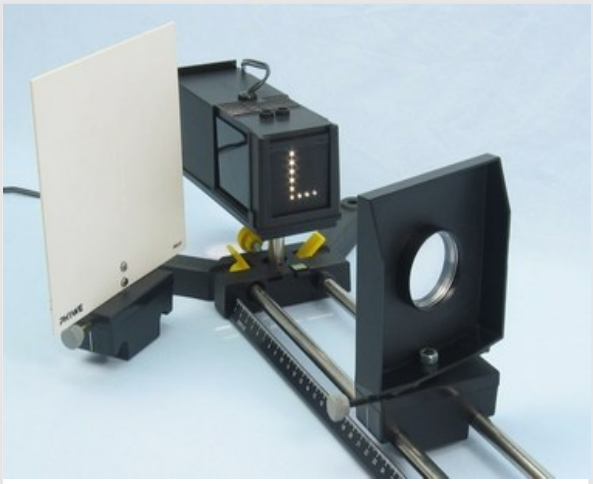

Experimental setup

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

Procedure (1/3)

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- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Set up the concave mirror in such a way that the object width $g = 210\,\mathrm{mm}$ place the shade in front of the lamp and make sure that the light from the Perl-L passes close to it.
- Move the screen so that the image of the Perl-L is as sharp as possible. If the image is distorted, you have to readjust it. To do this, turn the mirror or the screen slightly until the distortion is at its lowest.

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Procedure (2/3)

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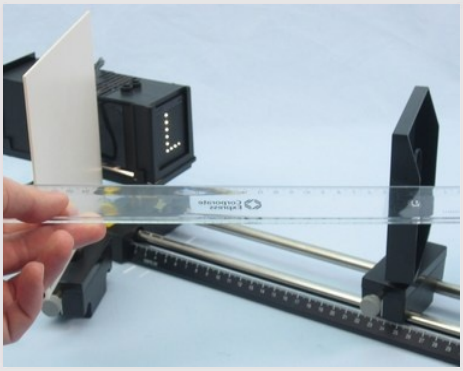
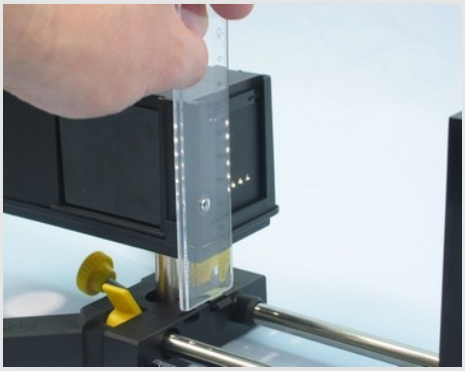
- Read the object width on the scale g and measure the image width b with the help of the ruler.
- Measure the item size G and the image size B. Enter the measured values in Table 1 in the report. G and B should be the distances between the centres of the top and bottom beads or their images.





Procedure (3/3)

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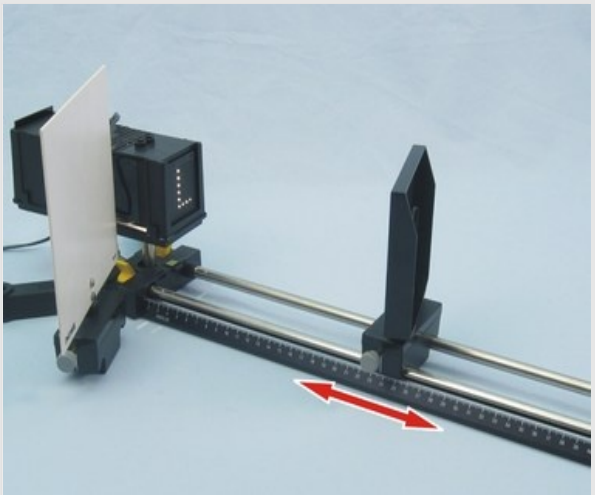

Variation of the mirror

- Move the mirror to the right, determine in the same manner g, b and B (G does not change) and enter the measured values in Table 1.
- Now place the shade next to the luminaire, also determine the corresponding measured values for 2 enlarged images and enter these as well.
- Switch off the power supply unit.

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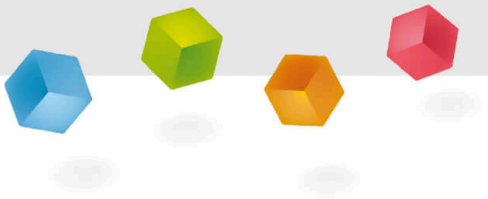

Report

Table 1

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Enter your measurements in the table.

g in mm	b in mm	G in mm	B in mm	b/g	B/G

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Task 1

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Compare the quotients in the individual rows of Table 1. What do you find?

- ○ The values contained in the penultimate column are smaller than the values in the last column.
- ○ The values contained in the last two columns are equal to zero.
- ○ The quotients B/G and b/g in the individual lines are (almost) the same.

Check

Task 2

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Write down the result of your considerations in mathematical form. (With this you can calculate the image size B of concave mirror images. One calls $A = B/G$ the scale of reproduction.)

- ○ $B \cdot G = b \cdot g$
- ○ $B/b = g/G$
- ○ $B/G = b/g$

Check

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Slide	Score / Total
Slide 20: Comparison of the quotients	0/1
Slide 21: Mathematical relation	0/1

Total 0 / 2

Solutions | Repeat | Export text

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