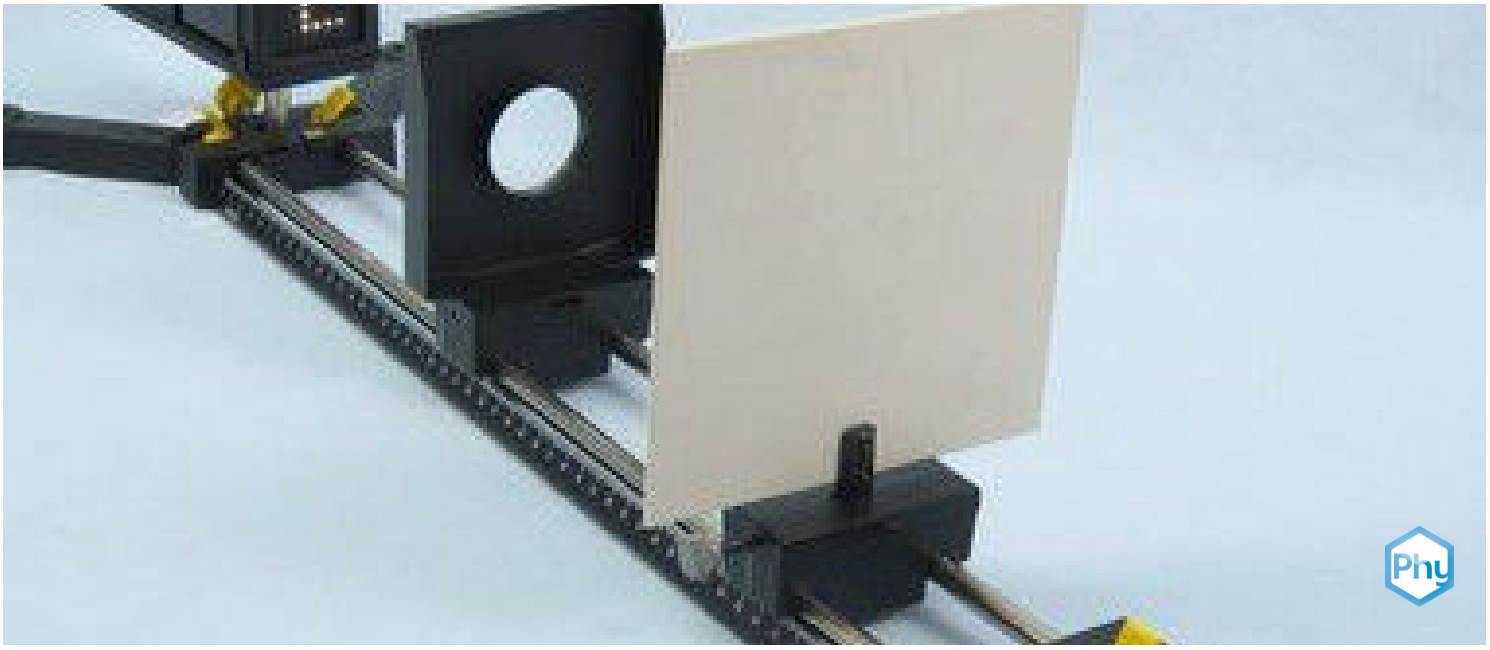
Law of imagery for a convex lens



Physics > Light & Optics > Optical devices & lenses

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/62dbc704a52f910003dffb87

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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Teacher information

Application

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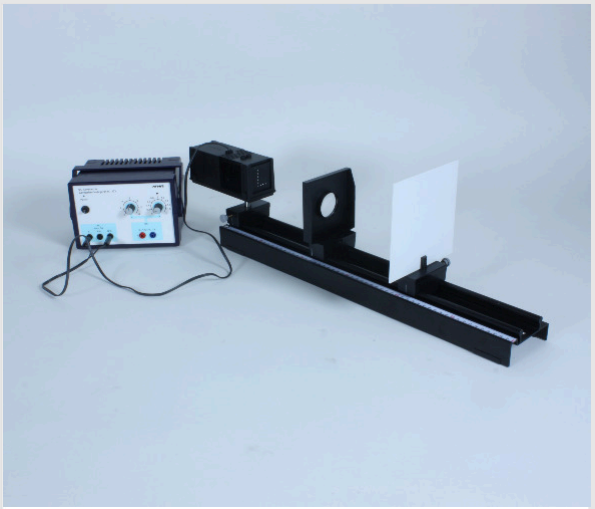

Experimental setup

Convex lenses, also called converging lenses, can produce a magnified image. They are an important element of ray optics and are therefore widely used in optical instruments and in photographic lenses.

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Robert-Bosch-Breite 10
37079 Göttingen

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Other teacher information (1/4)

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Principle

Incident light that is parallel to the optical axis is focused by the convex lens at the focal point. This can produce a magnified real image.

Learning objective

The students are asked to observe the optical effect of a convex lens and to explain the imaging law $1/f = 1/b + 1/g$

Other teacher information (2/4)

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Task

- The students should investigate what relationship there is between the focal length f, the subject matter g and the image width b when real images are created with the help of a convex lens.
- For this purpose, for given object widths g the image width b will be measured and noted in a table in the report.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Other teacher information (3/4)

- The law of mapping is generally first derived theoretically or simply given.
- It would also be conceivable for the students to experiment without prior knowledge of the law of mapping. In this case, however, the student would not understand why the reciprocals of f, g and b are to be formed.

Other teacher information (4/4)

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Notes on set-up and procedure

- The proposed experimental steps are intended to ensure that both enlarged and reduced images of the same size are produced.
- As another experiment technique, the teacher can also suggest that the students first place the screen in different places and then move the lens until the image is sharp.
- Do not carry out the experiment with the convex lens $f = 50\,\mathrm{mm}$ because the enlarged images created with it can no longer be focused. The condition that the rays are close to the axis is then no longer fulfilled.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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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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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Motivation

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Magnifying glass as an example of a convex lens

Convex lenses, also called converging lenses, can produce a magnified image. They are a central component of optics and are therefore often found in everyday devices, such as telescopes, camera lenses or even eyeglasses.

How do convex lenses work?

Tasks

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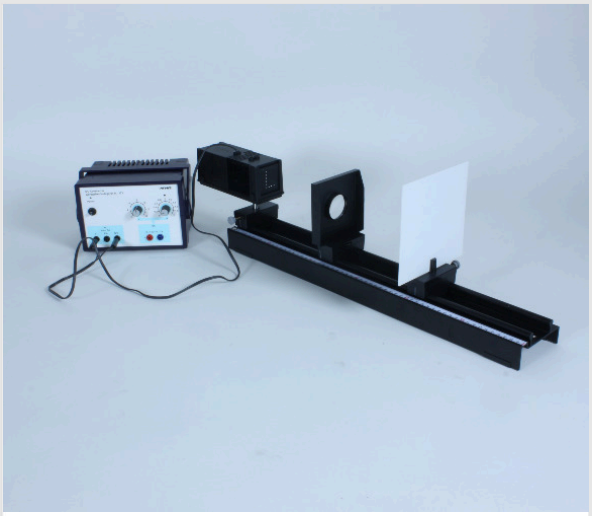

Experimental setup

- Investigate the relationship between the focal length f, the subject matter g and the image width b that exists when real images are created with the help of a convex lens.
- For this purpose, for the given object widths g you shall measure the image width b and note in a table in the report.

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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	Lens on slide mount, f=+100mm	09820-02	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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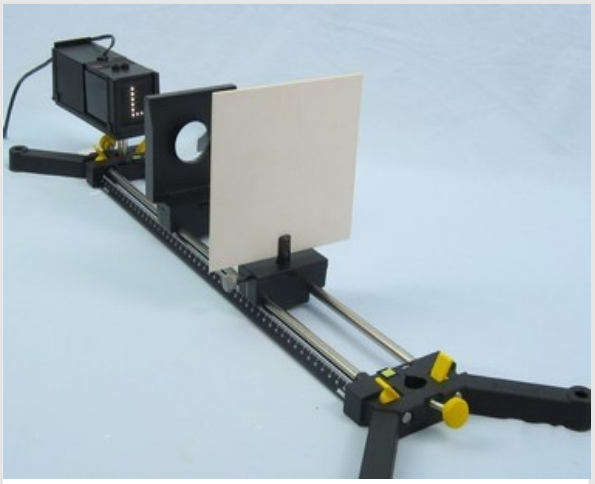

Experimental setup

- Place the lens and, with the help of the slide, the screen on the optical bench.

Procedure (1/3)

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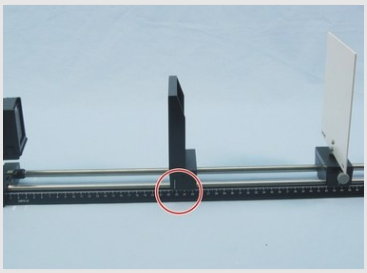

- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Place the lens at a distance of about 20 cm from the Perl-L and move the screen until the image of the Perl-L is as sharp as possible.

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Procedure (2/3)

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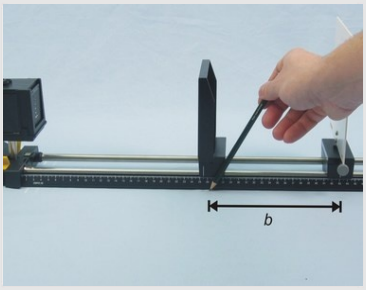

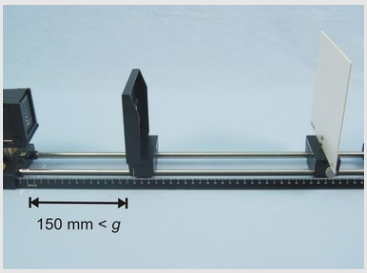

- Measure the distance of the lens from the screen, the image width b and carry for the object width $g = 200\,\mathrm{mm}$ in Table 1 in the report.
- Move the lens to the left and determine for two different object widths ($g > 150\,\mathrm{mm}$) the image widths.

Procedure (3/3)

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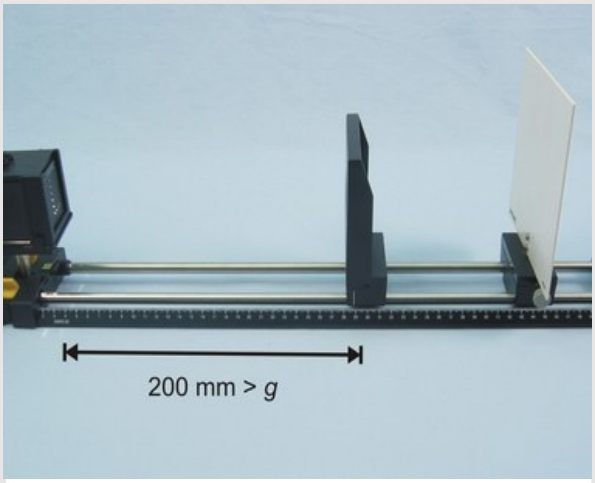

Displacement of the lens

- Then move the lens to the right and also determine for two different object widths ($g > 200\,\mathrm{mm}$) the image widths.
- Enter the values for g and b in Table 1 in the report.
- Switch off the power supply unit.

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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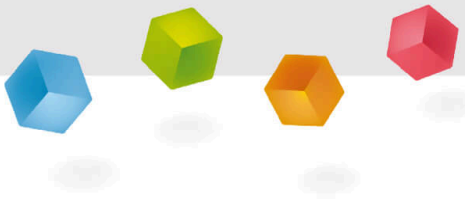

Report

Table 1

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Enter your measurements in the table.

g in mm	b in mm	$1/g$ in mm	$1/b$ in mm	$1/f$ in mm	$1/g + 1/b$ in mm
200	0.005		0.01		

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37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
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Task 1

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Compare the values in the last two columns of the table. What do you find?

- ○ The values contained in the last two columns are the same except for minor deviations.
- ○ The values contained in the last column are all greater than the values from the penultimate column.
- ○ No correlation can be found between values in the last and penultimate columns.

Check

Task 2

PHYWE

Calculate the mean value for the sum $1/g + 1/b$ and compare this with the value $1/f$. What is the result in mathematical form?

- ○ $1/f < 1/g + 1/b$
- ○ $1/f = 1/g + 1/b$
- ○ $1/f = 1/g = 1/b$

Check

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37079 Göttingen

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Task 3

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Why was it recommended in the experimental description to choose $g > 150\,\mathrm{mm}$?

- ○ If $g < 150\,\mathrm{mm}$ the image on the screen is only a virtual image.
- ○ If $g < 150\,\mathrm{mm}$ the image is created at such a great distance that the optical bench is no longer sufficient to catch it on the screen.
- ○ If $g < 150\,\mathrm{mm}$ the image on the screen is merely reversed.

Check

Task 4

PHYWE

What would happen in the event of $g = 100\,\mathrm{mm}$?

- ☐ $b = 0$ i.e. the image width is equal to zero.
- ☐ $b = g$ i.e. the object width is equal to the image width.
- ☐ $1/b = 0$ i.e. the reciprocal of the image width is equal to zero.
- ☐ $1/f = 1/g$ i.e. the object distance is as large as the focal length.
- ☐ $b = \infty$ i.e., the image lies in the infinite.

Check

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Robert-Bosch-Breite 10
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Task 5

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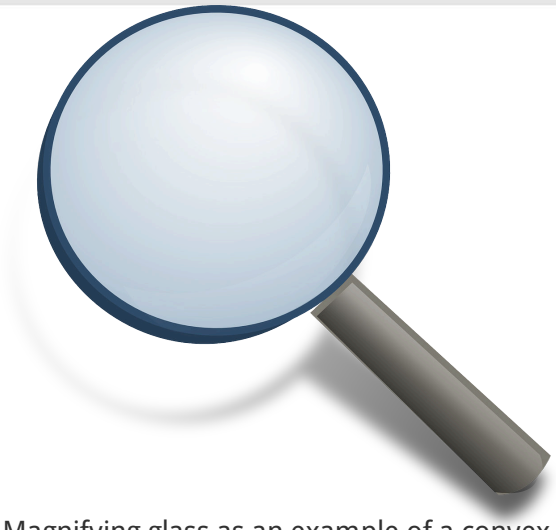
Fill in the blanks: What would happen in the event of $g < 100\,\mathrm{mm}$?

For $g < 100\,\mathrm{mm}$ the object distance is [ ] than the focal length f. [ ] images are created. These are not catchable on the [ ].

Check



Magnifying glass as an example of a convex lens

Slide	Score / Total
Slide 20: Comparison of the values	0/1
Slide 21: mathematical relation	0/1
Slide 22: Case \(g > 150 \, \mathrm{mm}\)	0/1
Slide 23: Case \(g = 100\, \mathrm{mm}\)	0/3
Slide 24: Case \(g < 100\, \mathrm{mm}\)	0/3

Total 0 / 9

Solutions Repeat Export text

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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