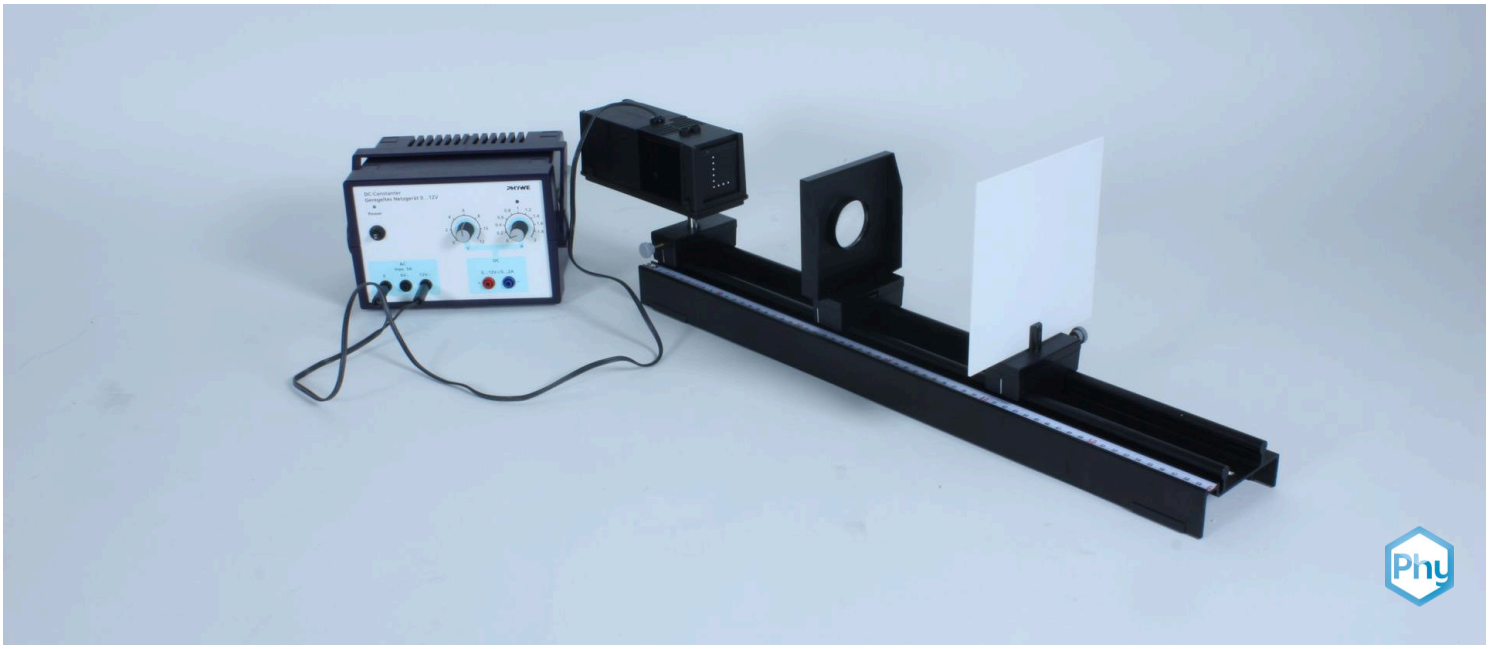
Image obtained with a convex lens



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/62ead6654daf930003bef508

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Teacher information

Application

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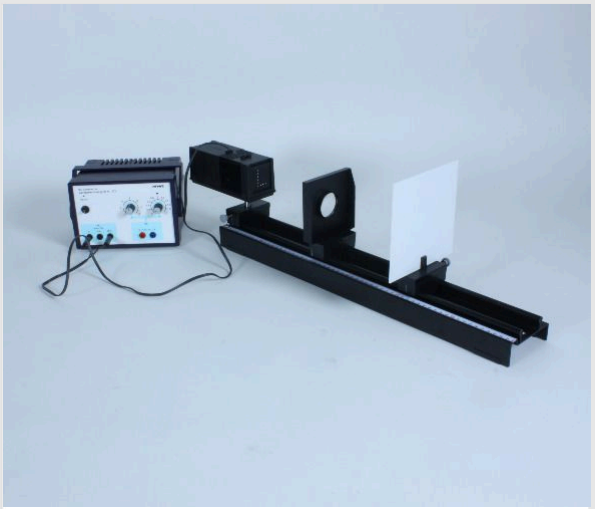

Experimental setup

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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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

Students should observe the optical effect of a convex lens, correctly classify the resulting images and understand the relationship between object width and focal length.

Other teacher information (2/4)

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Task

- Pupils should investigate what properties images have that are visible at different object widths ($g > 2f$, $g = 2f$, $2f > g > f$ and $g < f$) can be produced by a convex lens.
- The images should be described with the terms "real", "virtual", "reverse", "upright", "enlarged" or "reduced".

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Other teacher information (3/4)

This experiment is very demanding, although it does not make any increased demands on measurement accuracy. However, the acquisition of the individual cases for the image width, the properties of the image as a function of the object and focal length, the inequalities that occur as well as the multitude of technical terms often cause difficulties for the students, as experience has shown.

Methodological facilitation can be provided by a division of labour: The students are divided into four groups and each group works on one of the cases listed in the assignment. The results are then exchanged and entered in Table 1. In this way, each working group can complete its specific task carefully and without time pressure.

Other teacher information (4/4)

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Notes on set-up and procedure

- Instead of the lens with $f = +100\,\mathrm{mm}$, the $f = +50\,\mathrm{mm}$ lens can also be used . However, the enlarged images produced with this may be blurred at the edges, so students may have trouble focusing the image in this introductory experiment.
- In their investigations, when the students choose subject widths g between $100\,\mathrm{mm}$ and $150\,\mathrm{mm}$ the screen must be placed on the table as an extension of the optical bench.
- The case $g < f$ may initially cause difficulties for the students if the experiment is not planned as a confirmation experiment. In this case, after the students have not received an image on the screen, the teacher should indicate that they need to look through the lens in the direction of the light path in order to see the image.

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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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Spectacle lenses 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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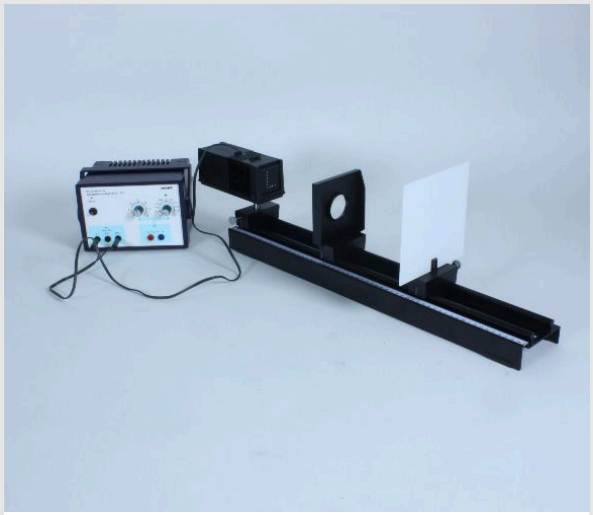

Experimental setup

Investigate what properties pictures have that are visible at different object widths ($g > 2f$, $g = 2f$, $2f > g > f$ and $g < f$) can be produced by a convex lens. Enter your results in the 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	1
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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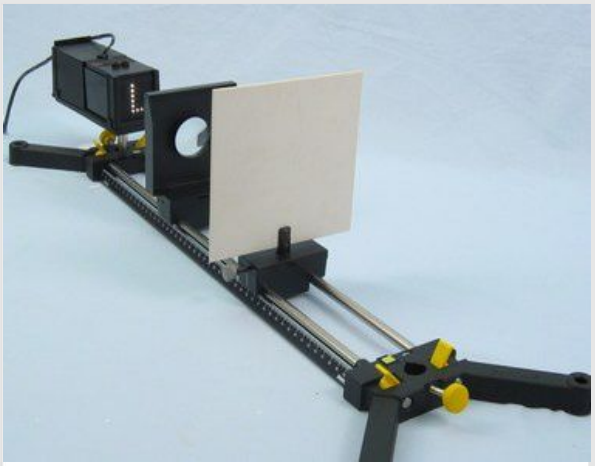

Experimental setup

- Insert the lens and screen into the experimental set-up as shown in Figure 7.

Procedure (1/2)

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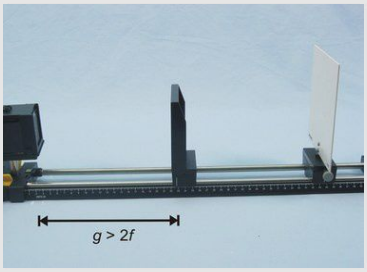

- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Select the distance of the lens from the Perl-L (the object width g) so that $g > 2f$.
- Then move the screen until the L is in focus on the screen.

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Procedure (2/2)

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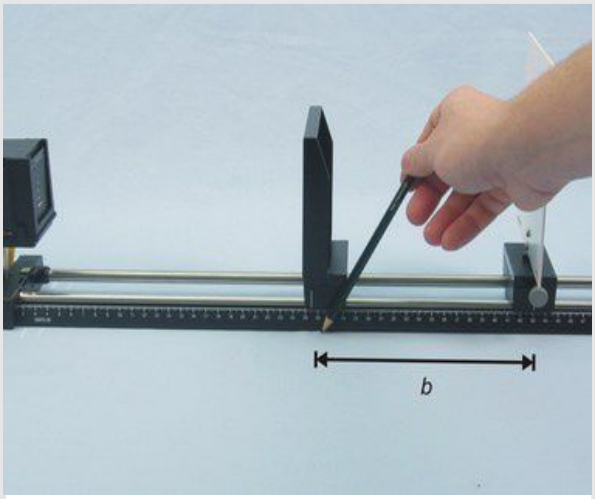

Measurement of the image width

- Measure the image width b and compare it with the focal length f. Look at the picture. Enter the results in the first row of Table 1 in the report.
- Use the words: "upright" or "inverted"; "enlarged", "reduced" or "equal"; "real" or "virtual" to indicate the three essential characteristics.
- Carry out the same steps for the remaining cases given in the task and complete Table 1 in the report.
- 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.

Subject width	Image width	Properties of theimage		
$g > 2f$	$2f > b > f$			
$g = 2f$		inverted		
$2f > g > f$			enlarged	
$g < f$				virtual

Task 1

PHYWE

Under which condition does a convex lens always produce a real image?

- ○ $g > f$ i.e., the object must be outside the (single) focal length.
- ○ $g = f$ i.e. the object must be exactly at the (single) focal length.
- ○ $g < f$ i.e., the object must be within the (single) focal length.

Check

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Task 2

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Under which condition does a convex lens always produce a virtual image?

- ○ $g > f$ i.e., the object must be outside the (single) focal length.
- ○ $g = f$ i.e. the object must be exactly at the (single) focal length.
- ○ $g < f$ i.e., the object must be within the (single) focal length.

Check

Task 3

PHYWE

What happens when the object is in the focal length of the convex lens ($g = f$)?

- ○ A virtual image is created.
- ○ No image is created. The image lies in the infinite.
- ○ A real image emerges.

Check

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Task 4

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What can you say about the images produced by a convex lens of which a piece (e.g. the lower half) has broken away?

- [ ] The images have the same properties.
- [ ] The images have the same light intensity.
- [ ] The images are fainter.
- [ ] The effect of a concave lens occurs.
- [ ] The images are brighter.

Check

Task 5

PHYWE

There is a simple optical device that is often used when you want to see small objects or details more clearly (magnified). What is the name of this device?

- ○ Burning lens
- ○ Magnifier
- ○ Cosmetic mirror

Check

By whom is this device often used?

- [ ] Teacher
- [ ] Precision mechanic
- [ ] Electrician
- [ ] Watchmaker
- [ ] Stamp collectors

Check

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Slide	Score / Total
Slide 19: Condition for a real image	0/1
Slide 20: Condition for a virtual image	0/1
Slide 21: Object distance = focal length	0/1
Slide 22: Image properties of a non-intact convex lens	0/2
Slide 23: Multiple tasks	0/4
Total	**0 / 9**

Solutions | Repeat | Export text

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