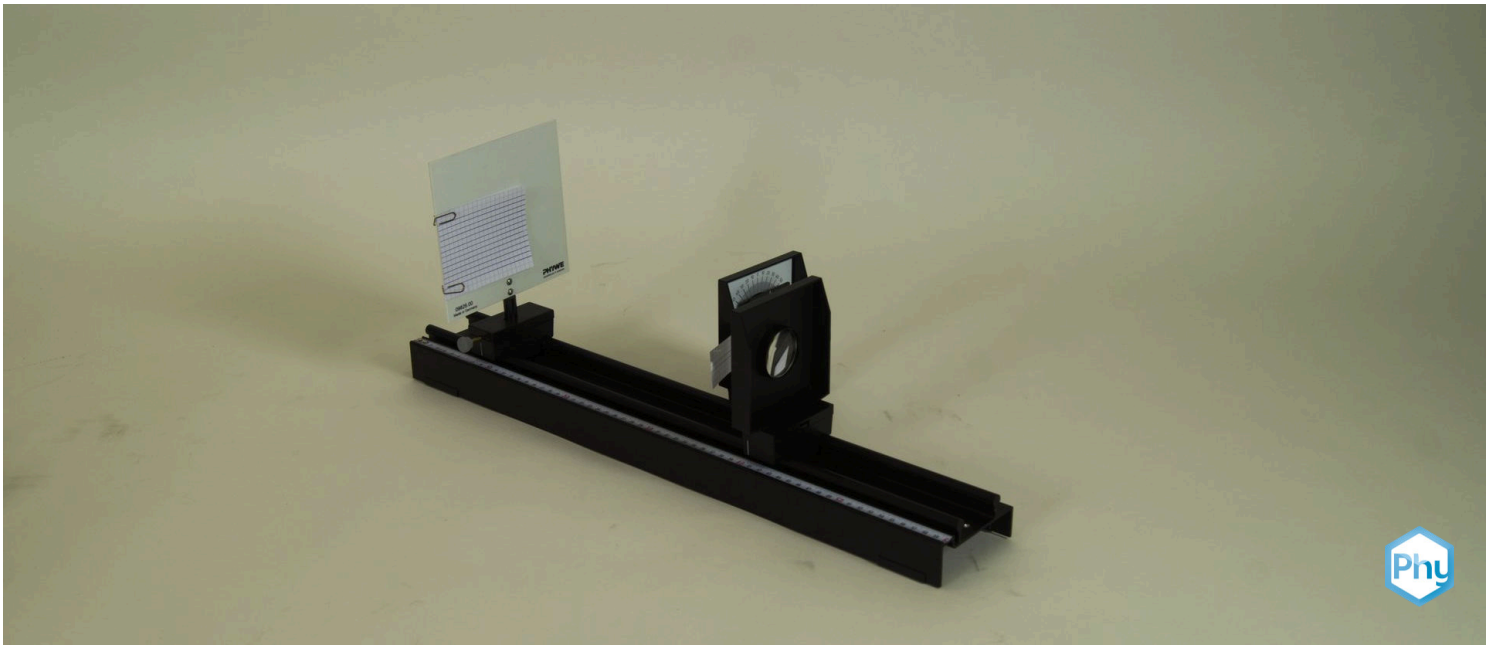
# The magnifying glass



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/62dd0d2a94c15900039bae08

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# Teacher information

## Application

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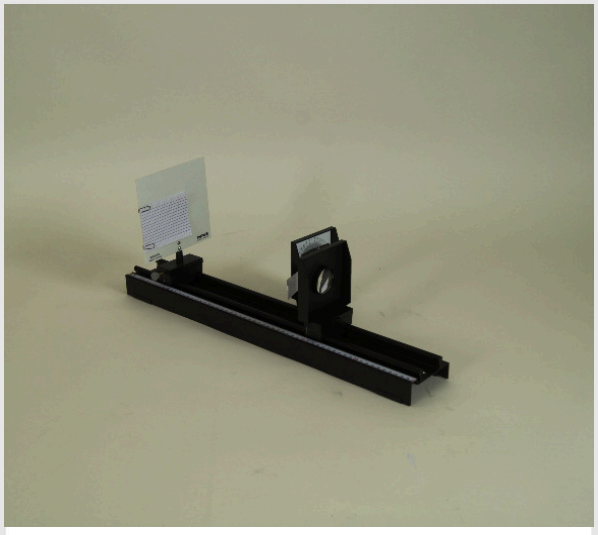

Experimental setup

Magnifying glasses are simple convex lenses, also called converging lenses, that can produce a magnified image. They are therefore often found in everyday situations.



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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 should observe the optical effect of a magnifying glass, i.e. a convex lens, and find out how to hold a magnifying glass so that they get the best possible magnification.

## Other teacher information (2/4)

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### Task

Students investigate how to use a magnifying glass as a visual aid by

1. Determining how to hold a magnifying glass to get the largest possible virtual image of an object that you can comfortably view.
2. Determining the magnification that magnifiers provide.



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# Other teacher information (3/4)

Although both parts of the experiment complement each other, it may be appropriate to use only one part or to have the parts done in different lessons. However, students should do the first part once, as it provides essential basics for understanding magnifying glasses.

**Notes:** The essential function of the magnifying glass is that it can be used to enlarge the angle at which the object is seen. At viewing angles smaller than one angular minute, the human eye cannot make out any details.

This could not be dealt with. However, because microscopes and telescopes are also based on the principle of magnifying the angle of view, this should be discussed at an appropriate point in the lesson.

# Other teacher information (4/4)

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## Notes on set-up and procedure

- In order to gain time for experimenting in class, it is advantageous if the scales are made at home by the students beforehand or are provided by interested students for everyone.
- When determining the magnification of the loupes, always look at the image in the centre of the loupe. At the edge, aberrations occur, especially with the 50 mm lens.



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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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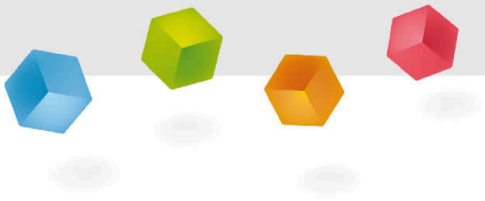

# Student information



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## Motivation

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Magnifier

Magnifiers are simple convex lenses, also called converging lenses, that can produce a magnified image. You can therefore use them as a reading aid or in other everyday areas.

**How should you hold a magnifying glass so that you get the best possible magnification?**

## Tasks

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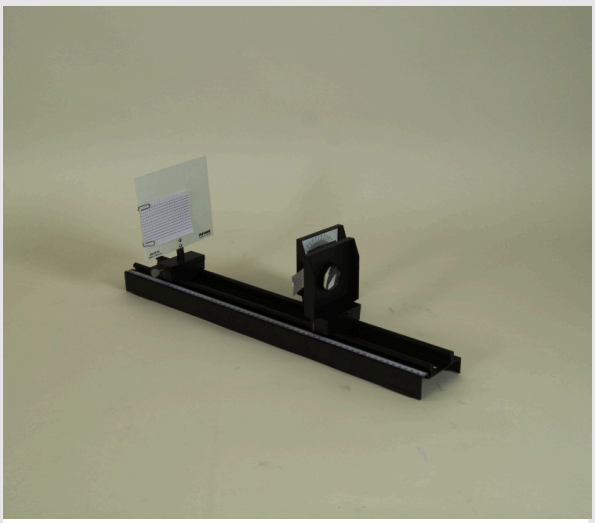

Experimental setup

Investigate how to use a magnifying glass as a visual aid by

1. Determining how to hold a magnifying glass to get the largest possible virtual image of an object that you can comfortably look at.
2. Determining the magnification that magnifying glasses produce.



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# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Optical profile-bench for student experiments, l = 600 mm | 08376-00 | 1 |
| 2 | Lens on slide mount, f=+50mm | 09820-01 | 1 |
| 3 | Lens on slide mount, f=+100mm | 09820-02 | 1 |
| 4 | Slide mount for optical bench | 09822-00 | 1 |
| 5 | Mount with scale on slide mount | 09823-00 | 1 |
| 6 | Screen, white, 150x150 mm | 09826-00 | 1 |
| 7 | Diaphragm holder, attachable | 11604-09 | 1 |



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# Experiment 1 - Setup

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## 1. Download print template:

- Download the print template (100% - no zoom) and print it out or take a sheet of paper with very small font. Click here to download the print template.
- Continue to the procedure of the experiment.

# Experiment 1 - Procedure

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- Take the print template or another sheet of paper with very small writing. Hold it about 50 cm away from your eyes and slowly bring the sheet closer to your eyes. What do you observe at distances of about 50 cm, 25 cm and 10 cm? Write down your observations in the report.
- Hold one eye about 10 cm above the sheet of paper and then hold the lens with $f$ = +100 mm between the sheet and your eye. Write down your observations in the report.
- Now hold the lens in such a way that you get the largest possible, upright, virtual image of the writing that you can comfortably look at. What is the distance of the lens, which now acts as a magnifying glass, from the writing in this case? Compare the distance with the focal length of the magnifying glass. Write down your observations in the report.



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# Experiment 2 - Set-up(1/4)

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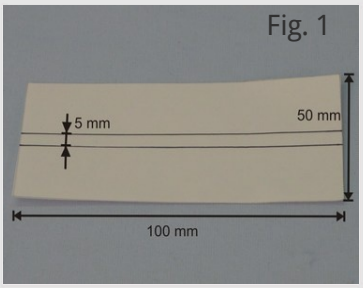

Fig. 1

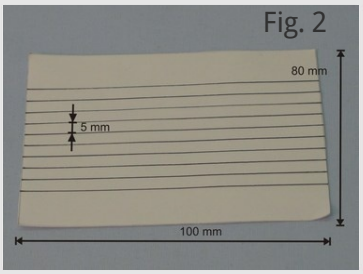

Fig. 2

## 2. Determine the magnification through the loupe:

- Cut out the two images from the print template.
- If you cannot print out the template, draw two horizontal lines 5 mm apart, reaching to the edge of a 50 mm x 100 mm sheet (fig. 1).
- Then draw at least 10 horizontal lines, each 5 mm apart, on a sheet of 80 mm x 100 mm (fig. 2).
- From now on, we will call the sheet of paper from Fig. 1 $M_F$ and the sheet of paper from Fig. 2 $M_S$.

# Experiment 2 - Set-up (2/4)

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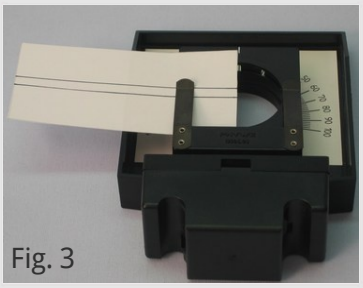
Fig. 3

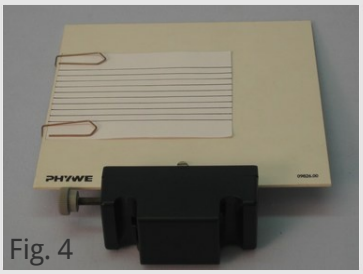

Fig. 4

- The scale $M_F$ is pushed into the aperture holder as in Fig. 3 and fixed to the mount with scale so that it protrudes 5 cm beyond the edge at the side, the two lines are horizontal and are level with the centre of the circular aperture.
- The scale $M_S$ is attached to the screen as in Fig. 4 so that the lines are horizontal and in the centre of the screen.



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## Experiment 2 - Set-up (3/4)

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Fig. 5

Fig. 6

- Set up the optical bench with the two stand rods and the variable stand foot (fig. 5) as in fig. 6 and place the scale on the front stand rod.

## Experiment 2 - Set-up (4/4)

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- Set the lens with $f = +50\,\mathrm{mm}$ at the 40 cm mark and the shade at the 15 cm mark on the optical bench. Place the frame with the scale behind the optical bench so that the scale is $M_F$ is above the 35 cm mark ( Fig. 7).

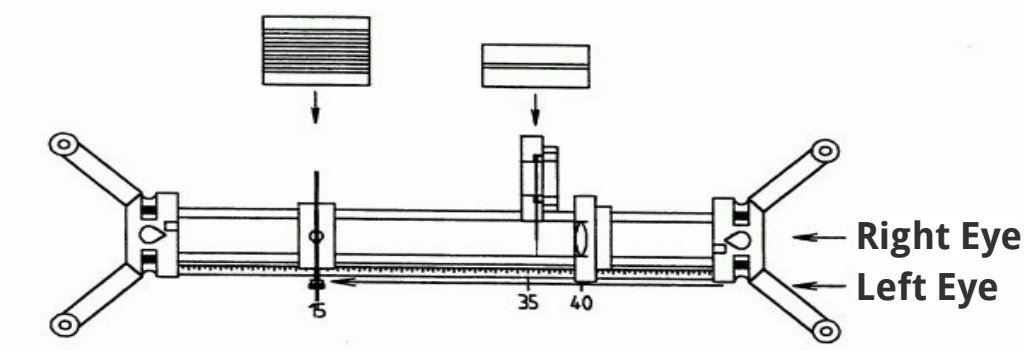


Fig. 7



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## Experiment 2 - Procedure (1/2)

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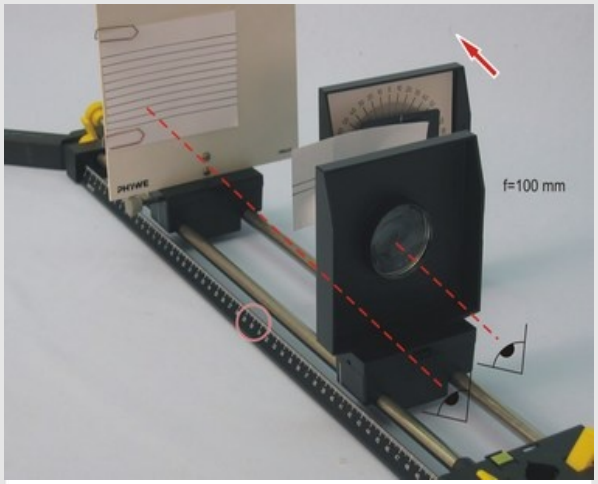


Fig. 8

- Move your right eye closer to the lens until the two lines of the scale are in line. $M_F$ appears sharp in the centre of the lens.
- Look with your left eye past the lens at the scale $M_S$.
- Count how many spaces between the lines on $M_S$ correspond to the distance between the two lines on $M_F$ (Fig. 8). Enter the number of these spaces in Table 1 in the report.

## Experiment 2 - Procedure (2/2)

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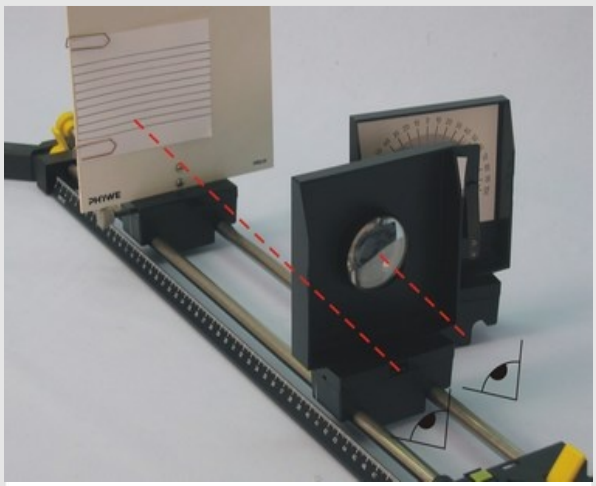

Fig. 9

- Set the scale $M_F$ over the 30 cm mark and, instead of the lens just used, set the lens with $f = +100\,\mathrm{mm}$to the 40 cm mark (Fig. 9).
- Repeat the measuring process. Enter the number of spaces now measured in Table 1 in the report.



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# Report

## Task 1

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Describe sharpness (blurred, sharp) and size of writing (illegible, very small, larger) in the 1st experiment at the following distances.

At 50 cm, the image is [ ] and the font [ ].

At 25 cm, the image is [ ] and the font [ ].

At 10 cm, the image is [ ] and the writing [ ].

Check



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## Task 2

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What is true if you have the typeface in the 1st attempt? **without** Lens? The typeface is...

- ☐ legible.
- ☐ illegible.
- ☐ out of focus.
- ☐ sharp.

Check

What is true if you have the typeface in the 1st attempt? **with** Lens? The typeface is...

- ☐ illegible.
- ☐ sharp.
- ☐ out of focus.
- ☐ legible.

Check

## Task 3

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How far must the distance of the magnifying glass be from the writing so that the writing can be magnified to the maximum and viewed comfortably? The distance must be...

- ○ be almost as large as the focal length of the magnifying glass.
- ○ be much smaller than the focal length of the magnifying glass.
- ○ be much larger than the focal length of the magnifying glass.

What is the distance of the magnifying glass from the writing (object)?

The distance is approx. _____ mm.

Check



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## Table 1

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Write down your measurements for the second experiment. The magnification obtained with a magnifying glass can be calculated with the equation $V = s/f$. Thereby $s$ is the clear (comfortable) visibility ($s = 25\,\mathrm{cm}$) and $f$ the focal length of the lens. Calculate the magnification for the lenses you used in the experiment and enter your results in the 3rd column of the table.

| Focal length $f$ in mm | Number of distances | Enlargement $V = s/f$ |
|---|---|---|
| 50 | | |
| 100 | | |

## Task 4

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In the experiment, you have determined how many spaces on the scale $M_S$ that correspond to one distance on the scale viewed through the magnifying glass $M_F$. This means that you have measured the magnification of the magnifying glasses. Since the measured values also depend on the individual eye adjustment of the experimenter, the result can vary between $V = s/f$ and $V' = s/f + 1$. Calculate $V' = s/f + 1$ and compare the magnification with the values from the table.

What do you find?

- ○ The experimentally determined values do not lie between $V = s/f$ and $V' = s/f + 1$
- ○ The experimentally determined values lie between $V = s/f$ and $V' = s/f + 1$

Check



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| Slide | Score / Total |
|---|---|
| Slide 21: Description of the image | 0/6 |
| Slide 22: Multiple tasks | 0/4 |
| Slide 23: Multiple tasks | 0/2 |
| Slide 25: Enlargement | 0/1 |

**Total** 0 / 13

Solutions | Repeat | Export text



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