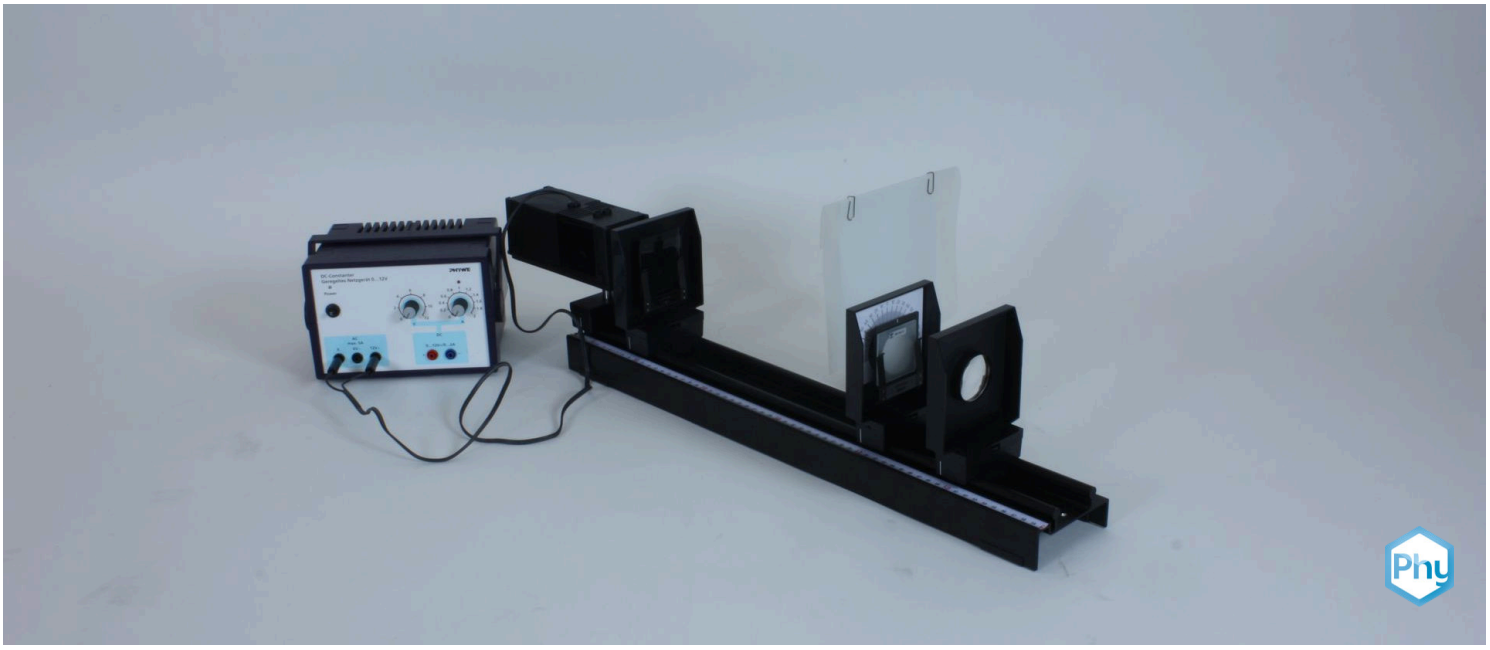
Determining the magnification of a microscope



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/62dd362194c15900039bae22

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Teacher information

Application

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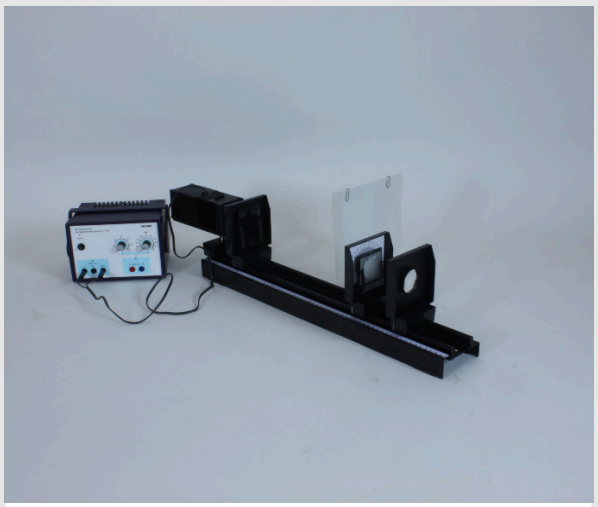

Experimental setup

Microscopes allow a highly magnified image of small objects that cannot be observed in detail by the human eye. The magnification is produced by optical lenses.

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Other teacher information (1/3)

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Principle

A light microscope consists of two components: an objective that produces a magnified intermediate image and an eyepiece that, like a magnifying glass, magnifies the intermediate image a further time.

Learning objective

Students should learn about the construction and function of a microscope and determine the magnification of the microscope.

Other teacher information (2/3)

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Task

- The students should build a microscope model and determine the magnification that can be achieved with it.

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Other teacher information (3/3)

- Although this experiment can be carried out immediately after an experiment on the construction and operation of a microscope, it is recommended that it be carried out as a separate experiment so as not to overtax the students.
- **Notes:** The second task and the required measurement of the variables b' and B' are an interesting addition to the treatment of the magnification of a microscope, but one can also do without them in order not to overwhelm the students. If the teacher also refers to the equation $M = M_1 \cdot M_2$ the following derivation of the equation can be used: The total magnification is $M = B/G$ with $G =$ Size of the object that is imaged by the objekitv and $B =$ Size of the image seen through the eyepiece. B' is the size of the intermediate image. Then: $M = B/G = (B/B') = M_1 \cdot M_2$.

Safety instructions

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

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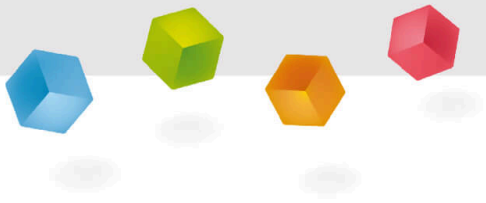
Student information

Student information



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Motivation

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Microscope

Microscopes allow a highly magnified image of small objects that cannot be observed in detail by the human eye. They are therefore an important tool in biology, medicine and material sciences.

How do microscopes work and how can you determine their magnification?

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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	Ground glass screen,50x50x2 mm	08136-01	1
5	Diaphragm with hole, d=20mm	09816-01	1
6	Lens on slide mount, f=+50mm	09820-01	1
7	Lens on slide mount, f=+100mm	09820-02	1
8	Slide mount for optical bench	09822-00	1
9	Mount with scale on slide mount	09823-00	1
10	Screen, white, 150x150 mm	09826-00	1
11	Diaphragm holder, attachable	11604-09	2
12	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 (1/4)

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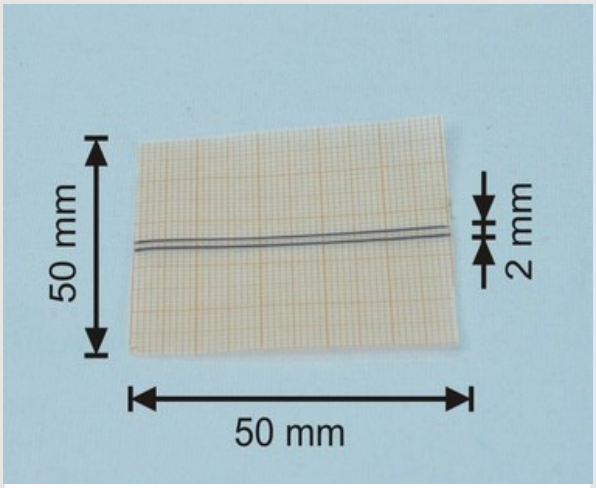

Milimeter paper

- Prepare the transparent graph paper with two lines as in the illustration.

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Set-up (2/4)

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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 (3/4)

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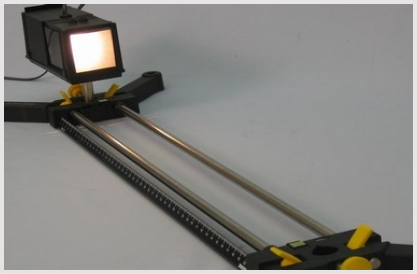
- Clamp the light box in the left part of the tripod base so that the lens side faces away from the optical bench.
- Slide an opaque screen in front of the lens and the transparent graph paper into the shaft at the other end of the light.

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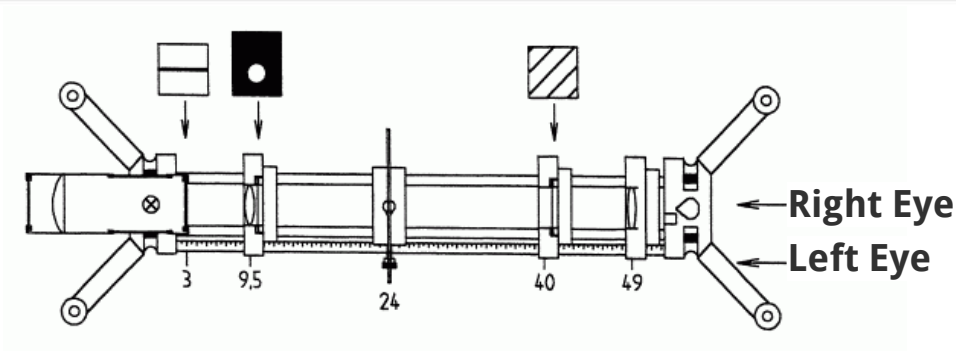
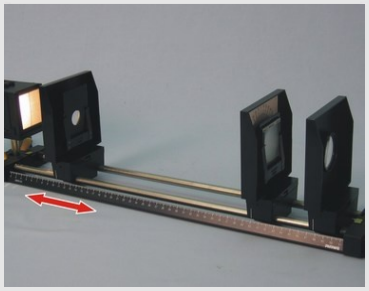
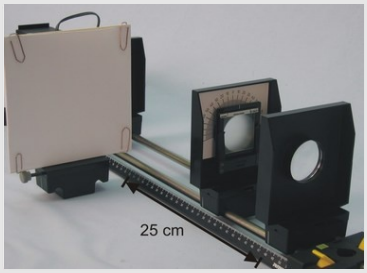
Set-up (4/4)

Set up the lens $f = +50\,\mathrm{mm}$ at 9.5 cm on the optical bench, place an aperture holder on the mount of this lens and slide the pinhole into the aperture holder. Place the scale mount at 40 cm on the optical bench, place the second aperture holder on top of it and slide it into the ground glass that will serve as the screen for the intermediate image. Set the lens with $f = +100\,\mathrm{mm}$ (the eyepiece) at about 49 cm onto the optical bench.



Procedure (1/3)





- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Make sure that the intermediate image of the two lines (object) on the ground glass is sharp. If necessary, readjust by moving the lens slightly.
- Look through the eyepiece at the intermediate image and move the eyepiece until the image of the intermediate image is sharp. Fasten the white sheet of paper tightly to the screen with the paper clips and place it in front of the optical bench with the tab at a distance of 25 cm from the eyepiece.

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Procedure (2/3)

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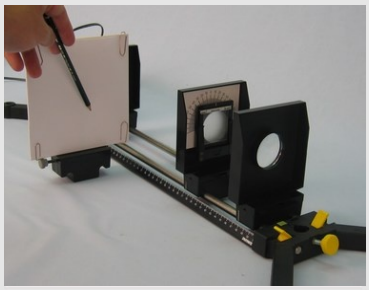

- Now look with your right eye through the eyepiece at the image and with your left eye past the eyepiece at the paper of the screen. Using a pencil or pen, mark on this paper the distance that appears to be the same as the distance between the two image lines in the eyepiece.
- Measure the distance B of the two marks on the paper of the screen (image size).

Procedure (3/3)

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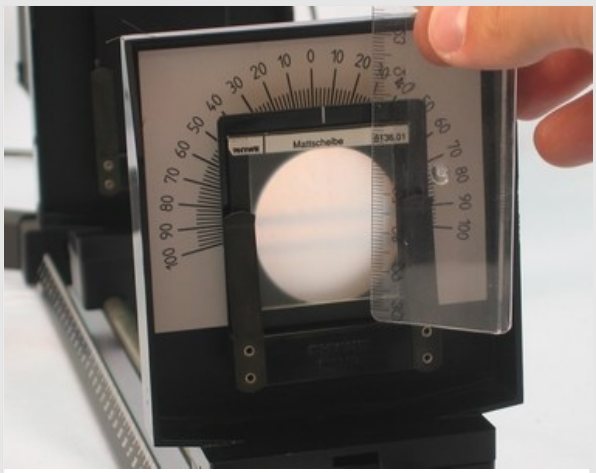

Measuring the size of the intermediate image on the ground glass screen

- Measure the size of the intermediate image B' i.e. the distance between the two lines on the ground glass.
- Measure the object width for the intermediate image g and the image width b'. Note down all measurement results in the report.
- Switch off the power supply unit.

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Report

Table 1

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Write down your measurement results in the table.

Spacing of the lines:

	Value in mm
Subject G	2
Picture (white screen) B	
Intermediate image (ground glass) B'	

Image through the lens:

	Value in cm
Subject width g	
Image width (intermediate image) b'	

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Task 1

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How to calculate the total magnification M of the microscope model?

- ○ $M = B/b$
- ○ $M = B/g'$
- ○ $M = B/G$

Check

This means that the total enlargement M = $\frac{\quad}{\quad}$ $\quad$

Task 2

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As with the microscope model also B' and g and b' can be measured for the intermediate image and as G is known, the enlargement can V also be determined. For the total magnification of the microscope the following applies: $M = M_1 \cdot M_2$, whereby M_1 and M_2 are the magnifications that the objective and the eyepiece achieve individually. Calculate the magnification of your microscope model using this method and compare the result with what you obtained in task 1.

For the lens applies: $M_1 = \frac{b'}{g} = \frac{B'}{G'} =$

For the eyepiece applies: $M_2 = \frac{25\ \mathrm{cm}}{f}$

Magnification of the microscope: $M =$

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