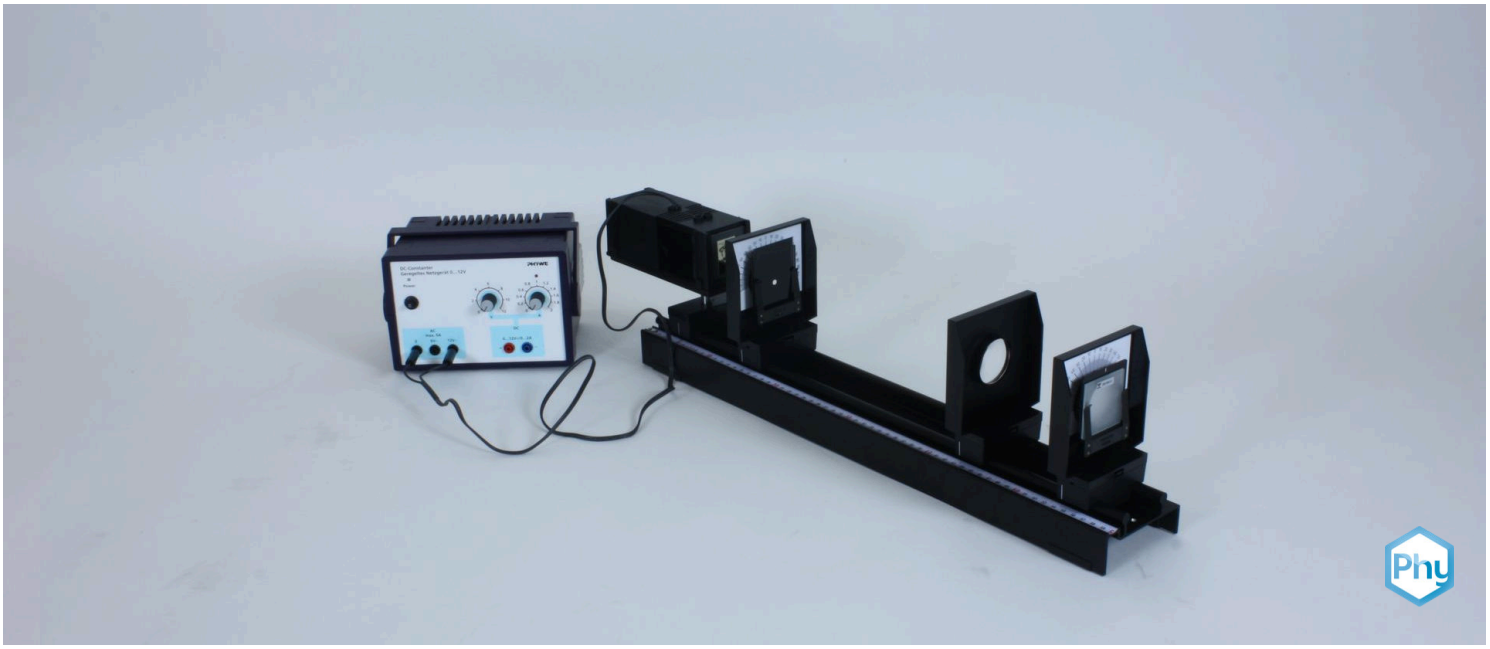
The structure of a microscope



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/62dd303594c15900039bae17

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Teacher information

Application

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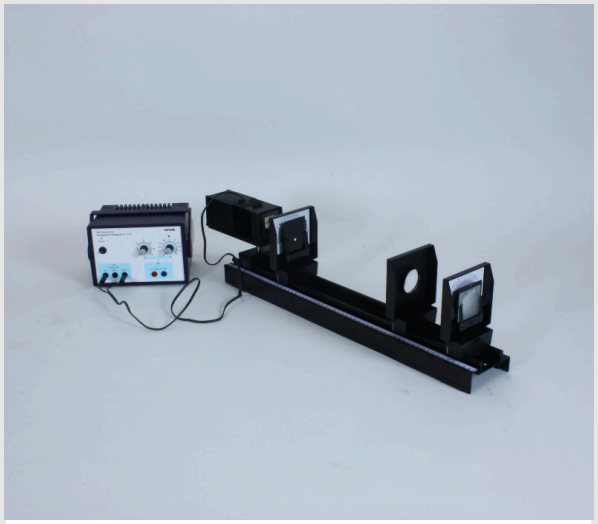

Experimental setup

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 observe its optical effect.

Other teacher information (2/3)

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Task

- Students should build a microscope model and investigate how its parts work together.

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Other teacher information (3/3)

- The experiment makes relatively high demands on the concentration and care while the students have to work with the physics room as completely darkened as possible. The lesson is best facilitated if the teacher uses it to confirm previously acquired theoretical knowledge about the microscope.
- **Notes:** The microscope with two converging lenses was used and described by Johannes Kepler. Ernst Abbe did much to decisively improve the magnification and image quality and worked out the physical principles for it. Carl Zeiss built the world-famous Zeiss microscopes according to Abbe's specifications.

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

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?

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Tasks

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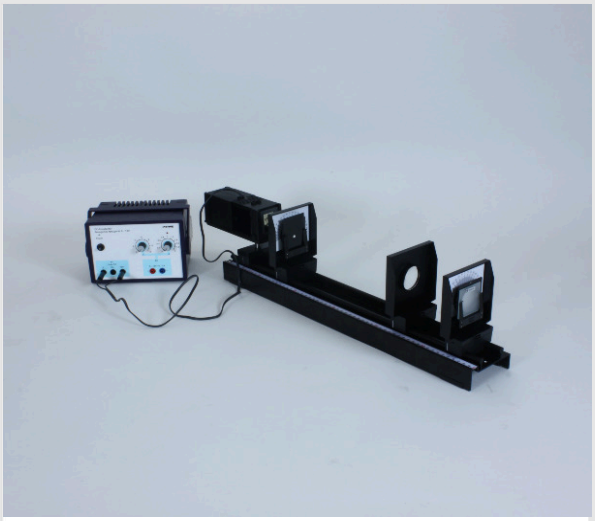

Experimental setup

- Build a microscope model and investigate how its parts work together.

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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	Diaphragms, d 1, 2, 3, 5 mm	09815-00	1
6	Diaphragm with hole, d=20mm	09816-01	1
7	Lens on slide mount, f=+50mm	09820-01	1
8	Lens on slide mount, f=+100mm	09820-02	1
9	Mount with scale on slide mount	09823-00	1
10	Diaphragm holder, attachable	11604-09	2
11	Slide -Emperor Maximilian-	82140-00	1
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 (1/3)

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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 screen in front of the lens and the slide into the shaft at the other end of the light.


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Set-up (3/3)

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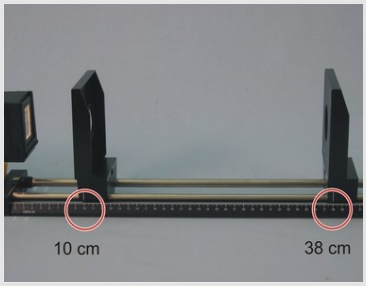

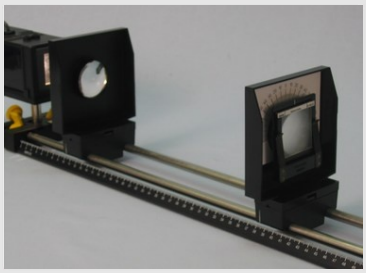

- Set up the lens with $f = +50\,\mathrm{mm}$ which serves as the objective of the microscope, at the 10 cm mark and the mount with scale at the 38 cm mark.
- Slide the focusing screen into an aperture holder and place it on the socket with scale.

Procedure (1/4)

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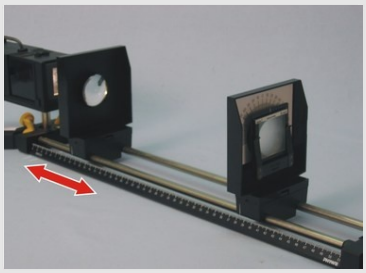

- First set the voltage regulator to 12 V. Then connect the lamp to the power supply unit and switch it on.
- Observe the image on the ground glass. Move the lens slightly until the image is sharp. Note the position and characteristics of this image, called the intermediate image.

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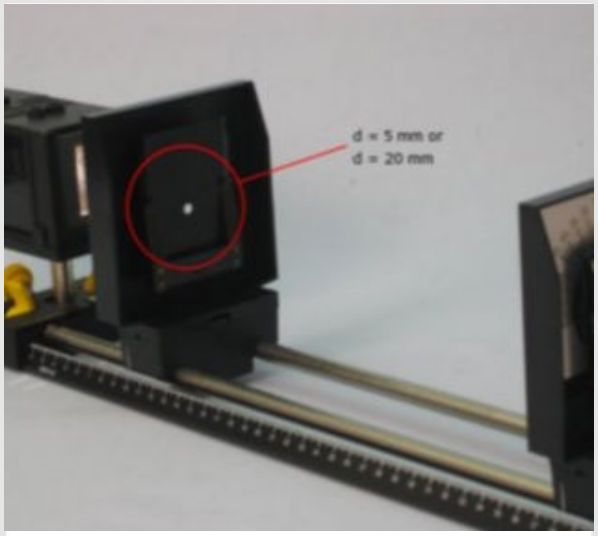
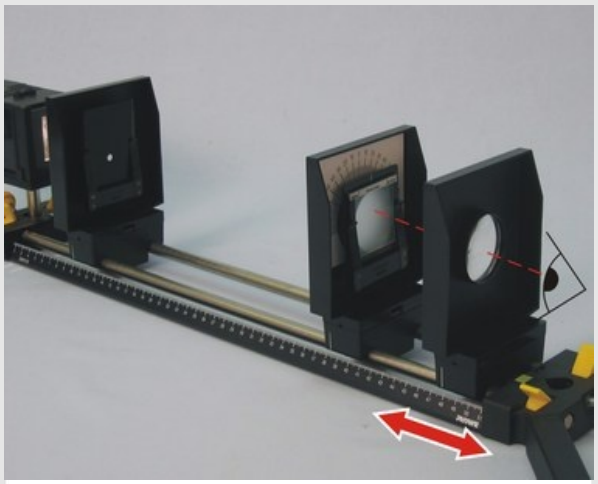
Procedure (2/4)



Inserting the diaphragm

- The intermediate image is distorted towards the edge. In the following, you only need the image section in the immediate vicinity of the optical axis.
- Therefore, slide one of the pinholes onto the second aperture holder and put it on the mount of the objective lens. Try out which hole size ($d = 5\,\mathrm{mm}$ or $d = 20\,\mathrm{mm}$) is better for the quality of the intermediate image. Adjust the aperture so that the image section is symmetrical to the optical axis.

Procedure (3/4)



Displacement of the eyepiece

- Now set the lens with $f = +100\,\mathrm{mm}$. At the 48 cm mark, place the eyepiece that serves as the microscope's eyepiece on the optical bench and look through it at the intermediate image. Move the eyepiece if necessary until the image you now see appears sharp.
- What are the properties of the image seen through the eyepiece? What is the effect of the eyepiece? Write down your answers.

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Procedure (4/4)

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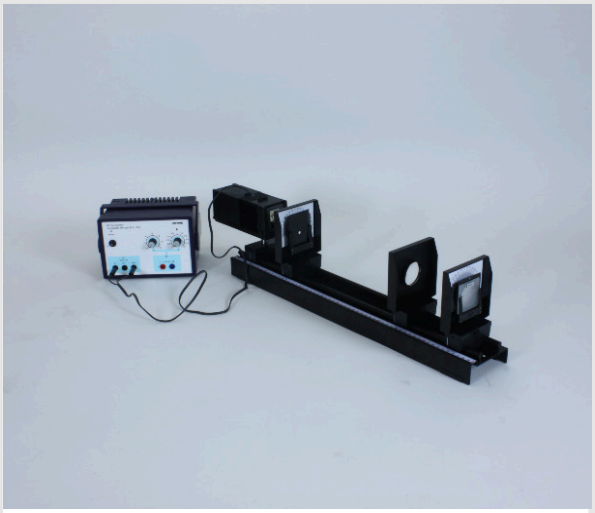

Experimental setup

- Remove the mount with the scale and thus the ground glass serving as a screen and look through the eyepiece again. The image that you now see through the eyepiece cannot have changed as a result. However, it is very much over-illuminated by the light from the light source. Therefore, lower the voltage on the lamp until the image is clearly visible again.
- Study the image that your microscope model has produced of very small details of the object again and then switch off the power supply.

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Report

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Task 1

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Observe the intermediate image. What is its position and what characteristics do you notice?

- [ ] It is within the focal length of the lens.
- [ ] It is enlarged.
- [ ] It is real.
- [ ] The intermediate image is outside the double focal length of the lens.
- [ ] It is the other way round.

Check

Task 2

PHYWE

What characteristics do you observe of the image seen through the eyepiece compared to the intermediate image? What is the effect of the eyepiece?

- [ ] The image is a reduced, virtual image of the intermediate image.
- [ ] The eyepiece acts as a magnifying glass.
- [ ] The image is an enlarged, real image of the intermediate image.
- [ ] The image is an enlarged, virtual image of the intermediate image.

Check

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Task 3

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In the practical version of a microscope, the objective and the eyepiece are mounted at the ends of a tube of adjustable length. (The tube serves to shield any light coming in from the side, which could make observation of the intermediate image difficult or impossible.)

The text below now describes the construction and functioning of a microscope. Fill in the missing words.

A microscope consists of a converging lens as a [ ] with a small focal length and a [ ] as an eyepiece with a larger focal length, which are mounted on the [ ] of a tube of adjustable length. The objective produces a magnified, inverted, real [ ] image of the object, from which the eyepiece produces a magnified, [ ] image.

Check

Task 4

PHYWE

You want to build a microscope and need the minimum length of the tube. Enter the missing relations ($<$, $>$ oder $=$) to estimate the minimum length. The focal length of the lens is f_1 and the eyepiece f_2.

Image width of the intermediate image is b [ ] $2\,f_1$.

The eyepiece has an approximate distance from the intermediate image as an object of g [ ] f_2.

Check

So what is the minimum length of a microscope tube?

- The minimum tube length is $l = f_1 + f_2$.
- The minimum tube length is $l = f_1 + \frac{f_2}{3}$.
- The minimum tube length is $l = 2\,f_1 + f_2$.

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Slide	Score / Total
Slide 19: Intermediate image	0/4
Slide 20: Properties of the image	0/2
Slide 21: Structure of a microscope	0/5
Slide 22: Multiple tasks	0/3

Total 0 / 14

Solutions Repeat

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