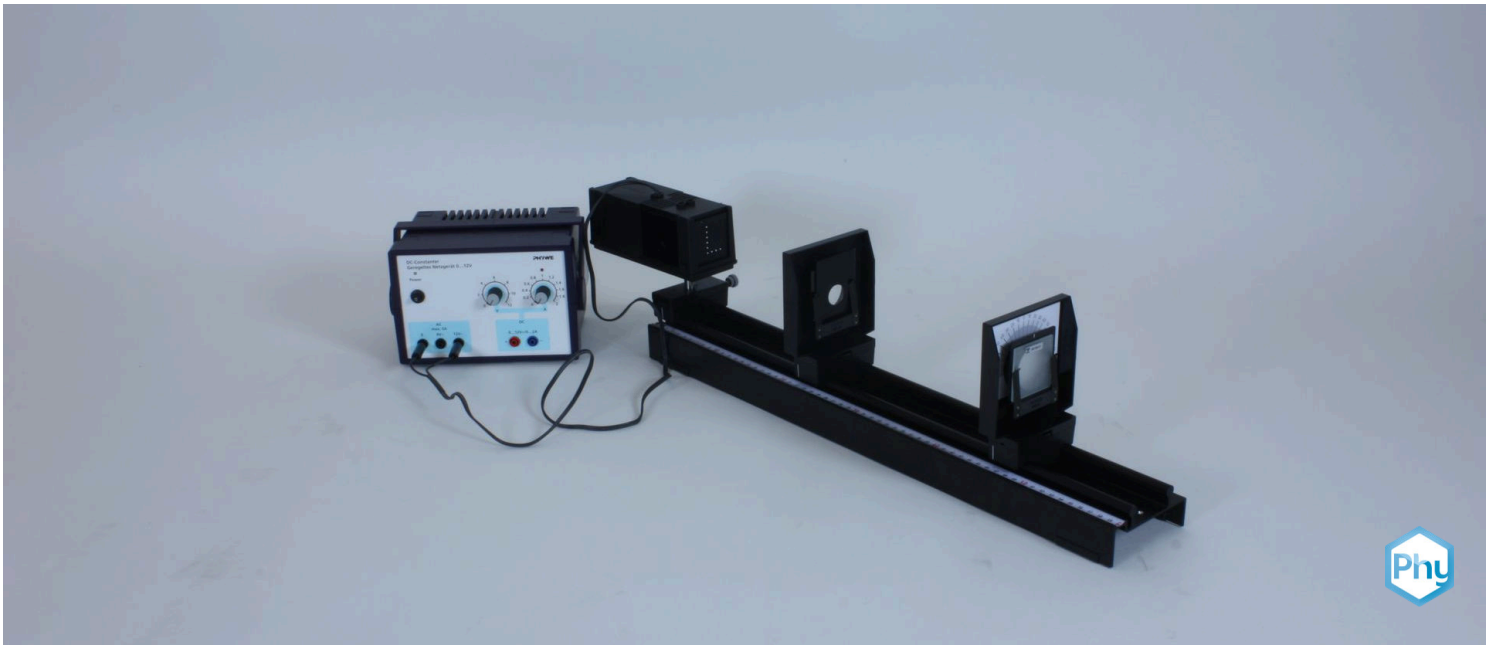
The camera



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/62dd798a318b270003e217c1

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Teacher information

Application

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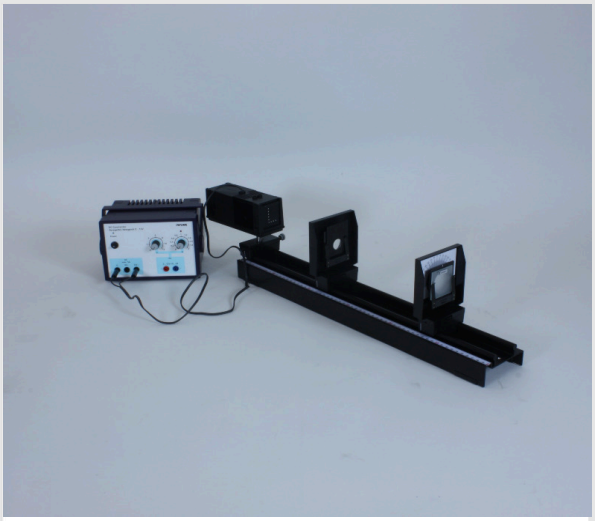

Experimental setup

Cameras can take single or multiple pictures and store them on a film. In the meantime, they have been almost completely displaced by digital cameras.

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Other teacher information (1/3)

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Principle

A camera usually consists of a lens that acts as a converging lens, an aperture that determines the brightness and sharpness of the image, and a film that stores the image. The distance between the lens and the film and the size of the aperture are variable.

Learning objective

The students should build a simple camera and learn the principles of light optics (magnification and imaging equation).

Other teacher information (2/3)

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Task

Ask students to build a model of a camera and investigate the following areas:

1. the dependence of the image size on the distance of the object from the camera,
2. the importance of the aperture for image quality,
3. the dependence of the image size on the focal length of the lens and
4. the validity of the equations $1/f = 1/g + 1/b$and $B/G = b/g$.

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Other teacher information (3/3)

The experiment makes average demands on the students' experimental skills. It provides them with essential knowledge about an optical device with which most of them are already relatively familiar. Experience has shown that they are sufficiently motivated to learn about the construction and functions of the camera.

Confirming the validity of the equations $1/f = 1/g + 1/b$and $B/G = b/g$is primarily intended for the consolidation of known learning content. If time is to be saved, this part of the experiment can be omitted, as it is not crucial for understanding the photo apparatus.

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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Camera

Cameras can take single or multiple pictures and store them on a film. In the meantime, they have been almost completely displaced by digital cameras.

How is a camera constructed and how does it work?

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Tasks

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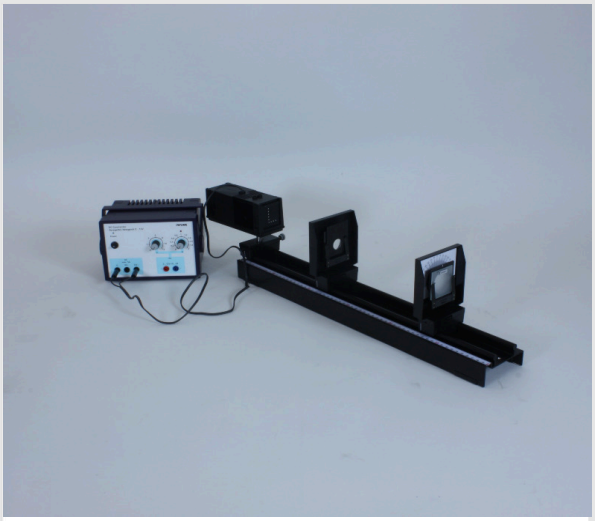

Experimental setup

Build a model of a camera and investigate:

1. the dependence of the image size on the distance of the object from the camera,
2. the importance of the aperture for image quality,
3. the dependence of the image size on the focal length of the lens and
4. the validity of the equations $1/f = 1/g + 1/b$and $B/G = b/g$.

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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	Object -L-, glass bead	11609-00	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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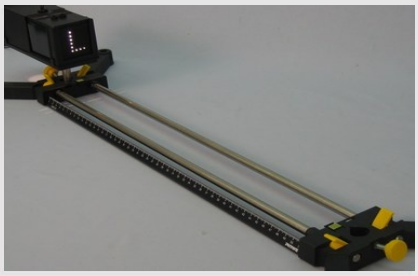
- Clamp the light box in the left part of the tripod base so that the lens side faces away from the optical bench.
- Slide an opaque shade in front of the lens and the Perl-L into the shaft at the other end of the luminaire.



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Set-up (3/3)

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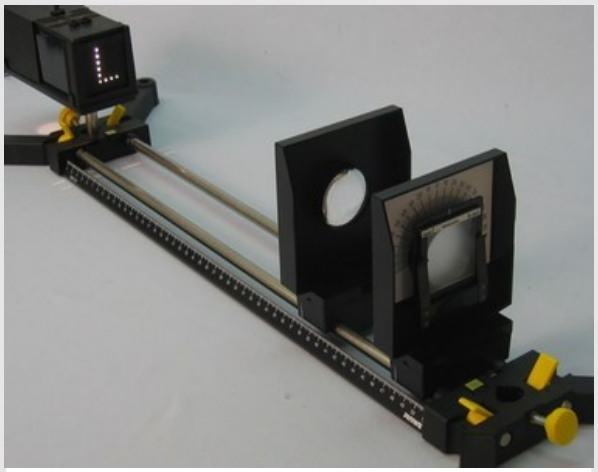

Experimental setup

- Place the frame with scale at the right end of the optical bench, put the focusing screen into an aperture holder and slide it onto the frame. (The focusing screen is the aperture of the camera model).
- Set the lens with $f = +50\,\mathrm{mm}$ (the lens) near the focusing screen.

Procedure (1/5)

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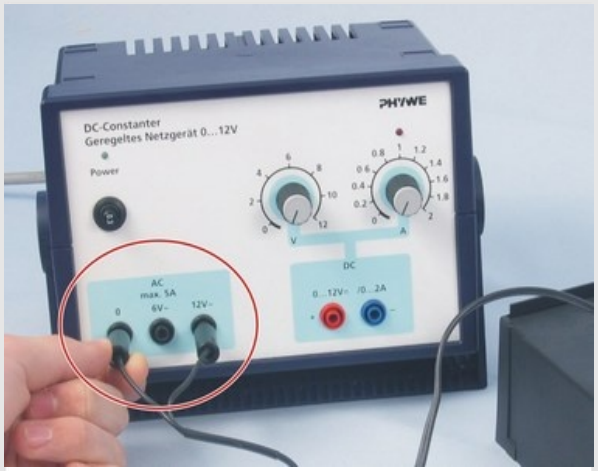

Power supply unit

- Connect the lamp to the power supply unit (12 V~) and switch it on.

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Procedure (2/5)

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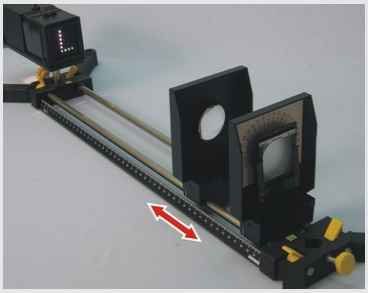

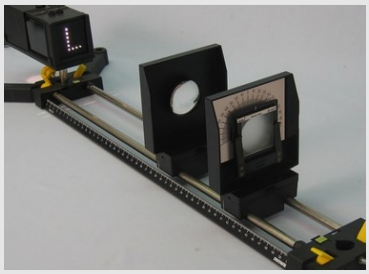

Experiment 1:

- Look towards the light path on the ground glass and move the lens until the sharpest possible image of the Perl-L appears on the ground glass. Note the size of the image.
- Bring the camera closer to the subject: move the focusing screen back to about the centre of the optical bench and use the lens to bring the image back into focus.
- How big is the picture now? Write down your observations in a sentence about the relationship between the distance of the object and the size of the picture.

Procedure (3/5)

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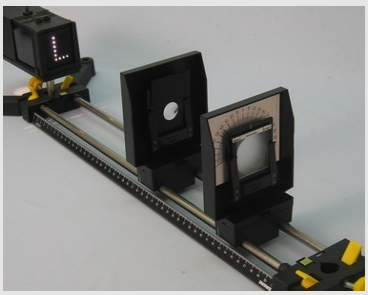

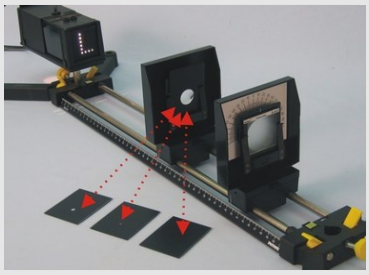

Experiment 2:

- Now slide the pinhole with $d = 20\,\mathrm{mm}$ onto the second aperture holder and put it onto the lens mount. Observe the image.
- Instead of the pinhole, use $d = 20\,\mathrm{mm}$ also the pinholes with $d = 5\,\mathrm{mm}$ and $d = 3\,\mathrm{mm}$. How is the picture changing?
- Note down your observations.

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Procedure (4/5)

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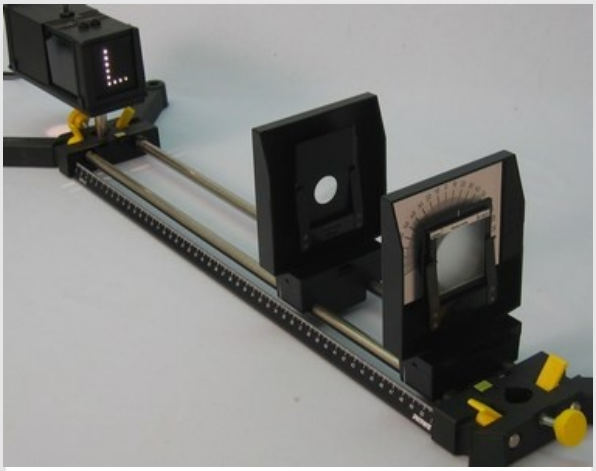

Experimental setup

Experiment 3:

- Move the focusing screen back to the end of the optical bench and, using the pinhole, adjust with $d = 20\,\mathrm{mm}$ a picture that is as sharp as possible.
- Replace the lens with the lens with $f = +100\,\mathrm{mm}$ and create a sharp image of the Perl-L.
- What can you say about the size of this image compared to the one produced with the smaller focal length lens? Write down your findings.

Procedure (5/5)

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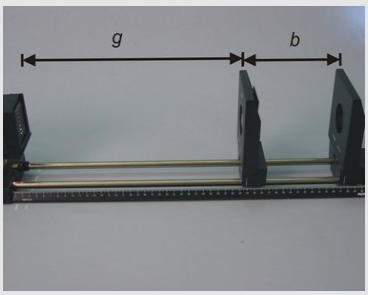

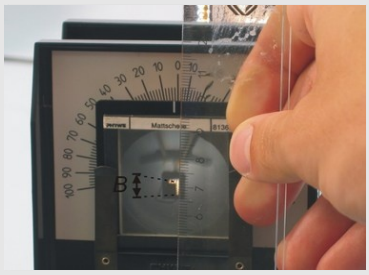

Experiment 4:

- Measure the object width g and the image width b, as well as the object size G and the image size B. (Note that G for the bead L is the distance between the centres of the outer beads).
- Record your readings in the report
- Switch off the power supply unit.

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Report

Task 1

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What do you observe on the first experiment?

- ○ The smaller the distance of the camera from the object, the larger the image.
- ○ The image size remains the same no matter how far the camera is from the subject.
- ○ The smaller the distance of the camera from the object, the smaller the image.

Check

What do you observe on the second experiment?

- ○ The smaller the aperture, the sharper and brighter the image.
- ○ The smaller the aperture, the sharper and darker the image.
- ○ The image is darker the smaller the aperture. The sharpness does not change.

Check

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Task 2

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What do you observe on the third experiment?

- ○ The image size does not change, no matter how large the focal length.
- ○ The smaller the focal length of the lens, the larger the image.
- ○ The larger the focal length of the lens, the larger the image.

Check

Note down your readings for the 4th experiment.

Size	Value [mm]	
Focal length f	100	
Subject width g		
Image width b		
Item size G		
Image size B		

Task 3

PHYWE

What are the main parts of a camera and how is it focused? Fill in the missing words.

A camera consists of a [ ], a [ ] with adjustable opening and a holder for the [ ] (a carrier for the light-sensitive layer). The distance of the lens from the film plane is adjustable. The whole is to be surrounded by a [ ]-impermeable housing. Focusing is done by changing the [ ] of the lens from the image plane, i.e. by changing the [ ].

Check

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Task 4

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How does reducing the aperture affect image quality?

- ○ Reducing the aperture results in greater image sharpness and lower image brightness.
- ○ Reducing the aperture results in less image sharpness and greater image brightness.

Check

What do you have to do to ensure that the picture is sufficiently exposed if you want to set a small aperture when shooting?

- ○ You have to increase the exposure time.
- ○ You have to reduce the exposure time.
- ○ You have to focus the image.

Check

Task 5

PHYWE

Calculate the reciprocal of the focal length f and the sum of the reciprocals of the object width g and image width b:

- $1/f = /$ c
- $1/g + 1/b = /$ c

So if the mapping equation applies $1/f = 1/g + 1/b$?

○ True ○ False

Check

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Task 6

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Calculate the quotients B/G and b/g:

- $B/G =$ ____
- $b/g =$ ____

So if the equation for the magnification applies $B/G = b/g$?

○ True ○ False

Check

Slide	Score / Total
Slide 20: Multiple tasks	0/2
Slide 21: Image size	0/1
Slide 22: Components of a camera	0/6
Slide 23: Multiple tasks	0/2
Slide 24: Mapping equation	0/1
Slide 25: Magnification	0/1

Total 0 / 13

Solutions Repeat Export text

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