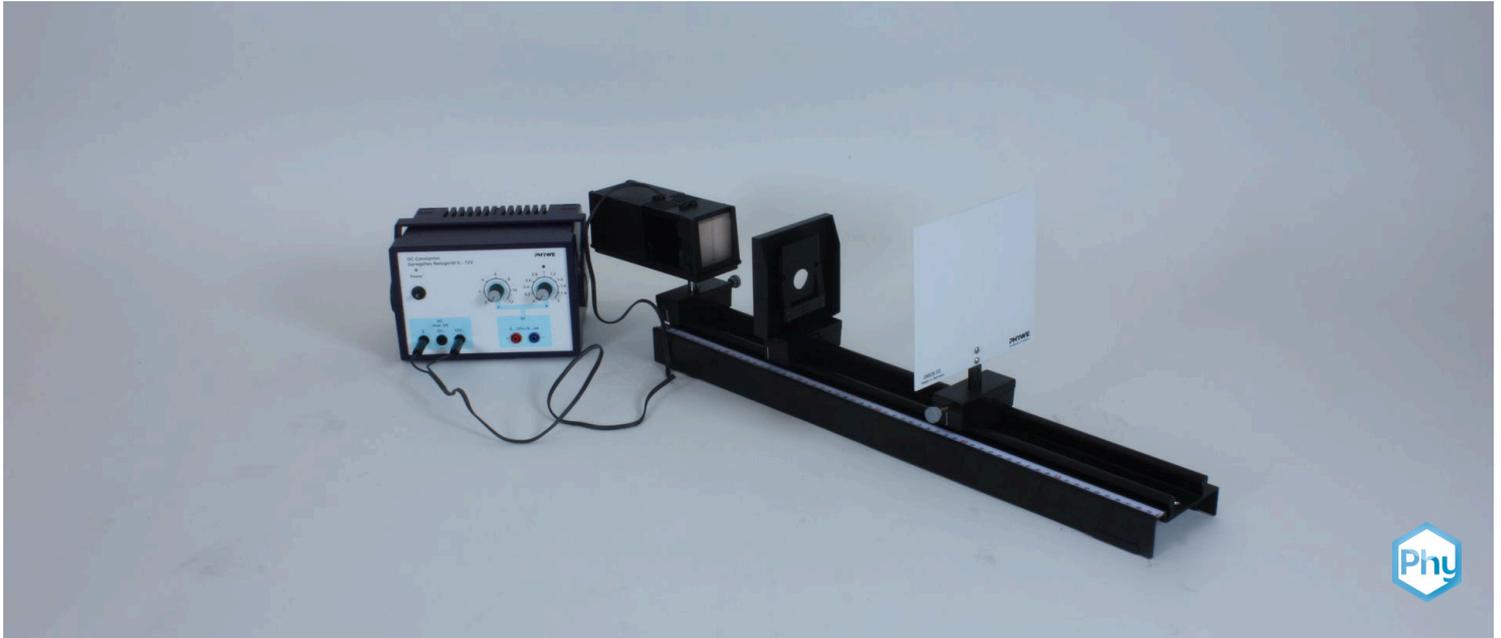


# The depth of focus of a camera



Physics

Light &amp; Optics

Optical devices &amp; lenses



Difficulty level

easy



Group size

1



Preparation time

10 minutes



Execution time

10 minutes

This content can also be found online at:



<http://localhost:1337/c/62e17d7c8248420003226dd6>

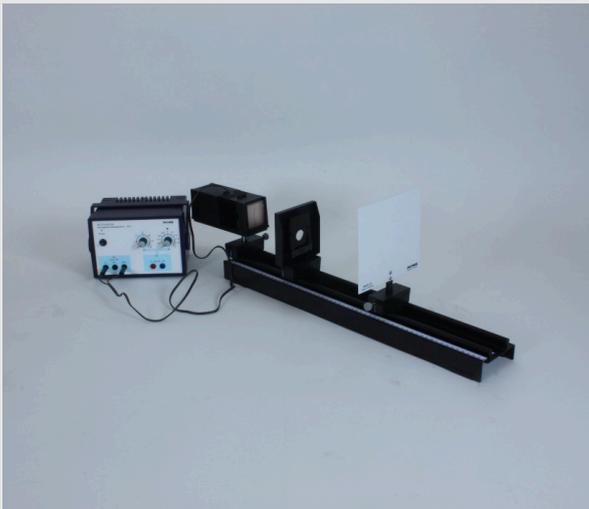
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## Teacher information

## 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.

## Other teacher information (1/4)

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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 are asked to construct a simple camera and investigate the function of the pinhole.

## Other teacher information (2/4)

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### Task



The students should build a model of a camera and investigate the influence of using pinholes with different pinhole diameters on the depth of field of a camera.

## Other teacher information (3/4)



The experiment can be used as an interesting supplement to an experiment on the construction and operation of the photographic apparatus. Based on such an experiment, the pupils will be sufficiently qualified to be able to handle the equipment safely even if the room is necessarily completely dark.

## Other teacher information (4/4)



### Notes on set-up and procedure

- It is not necessary and also not recommended to use the apertures with  $d = 2 \text{ mm}$  and  $d = 1 \text{ mm}$ , as the images will then be too faint.
- The use of the screen has the advantage that it enables high-contrast images. The use of a ground glass screen in this case is not advantageous for the image quality.
- It is to be expected that the measured values for depth of field differ greatly. They are highly dependent on what the individual students subjectively still perceive as a sharp image. However, this is not essential for understanding the basic relationship between aperture opening and depth of field. It may be the case, for example, that the students indicate the depth of field  $S = 0$  when using the pinhole diaphragm with  $d = 20 \text{ mm}$ .

## Safety instructions

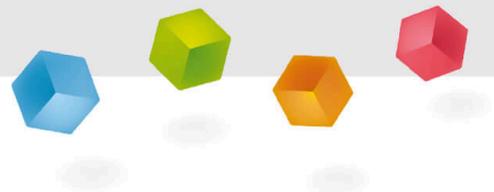
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- The general instructions for safe experimentation in science lessons apply to this experiment.

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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 does the aperture affect the depth of field of a camera?**

## Tasks

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Experimental setup

Build a model of a camera and investigate what influence the use of pinholes with different pinhole diameters has on the depth of field of a camera.

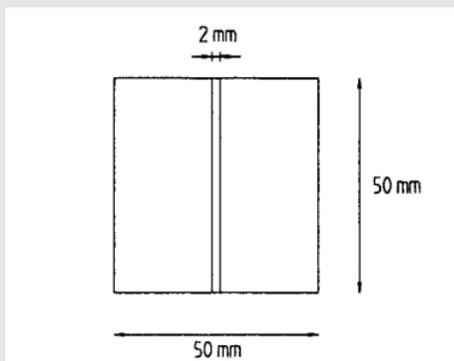
## Equipment

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	Diaphragms, d 1, 2, 3, 5 mm	09815-00	1
5	Diaphragm with hole, d=20mm	09816-01	1
6	Lens on slide mount, f=+50mm	09820-01	1
7	Slide mount for optical bench	09822-00	2
8	Screen, white, 150x150 mm	09826-00	1
9	Diaphragm holder, attachable	11604-09	2
10	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

## Set-up (1/3)

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- Prepare the transparent graph paper.
- Set up the optical bench with the two tripod rods and the variable tripod foot and place the scale on the front tripod rod.



## Set-up (2/3)

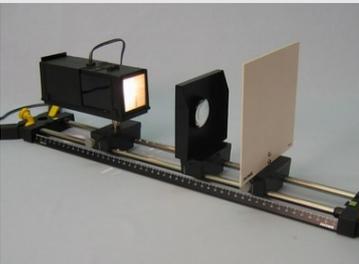
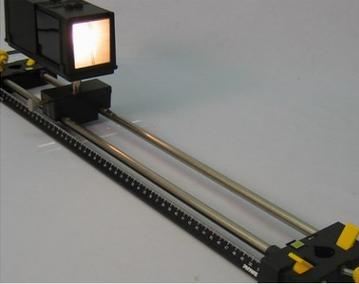
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- Place the base with the stem under the light box and, using the slide at the 15 cm mark, position it with the lens side facing away from the optical bench.



## Set-up (3/3)

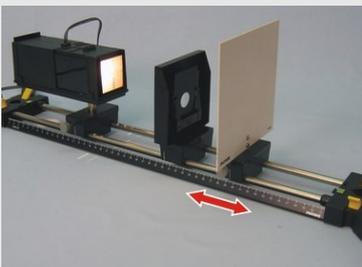
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- Slide an opaque screen in front of the lens and the transparent graph paper into the shaft at the other end of the light so that the lines are vertical.
- The graph paper is located as an object on the 18 cm mark.
- Set the lens with  $f = +50 \text{ mm}$  which serves as the lens of the camera model, at 30 cm and the screen (image plane of the camera) at about 40 cm.
- Slide the pinhole with  $d = 20 \text{ mm}$  into the aperture holder and place it on the mount of the objective lens.

## Procedure (1/3)

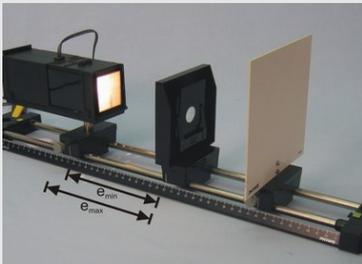
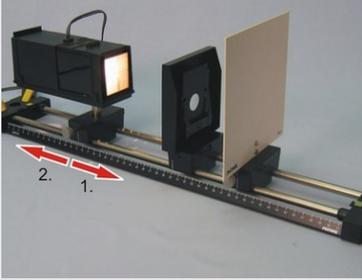
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- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Move the screen until the sharpest possible image of the object appears.
- **Hint:** In the following, the objective lens should not be moved with the aperture, but should always remain at the 30 cm mark.

## Procedure (2/3)

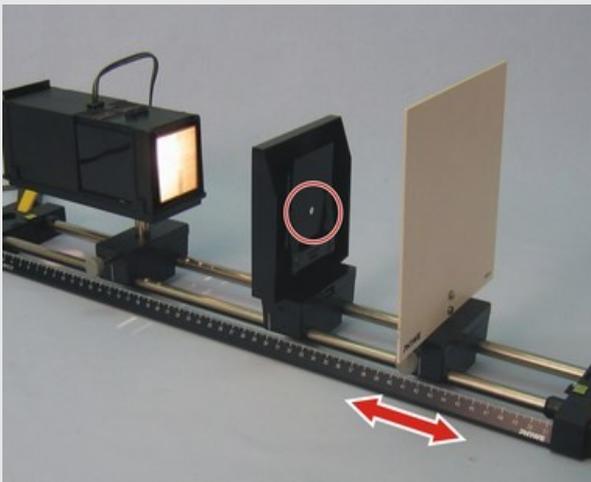
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- Now move the object as far towards the lens and then as far away from the lens until the image can just be seen as sharp.
- Repeat the process and measure the largest ( $e_{\max}$ ) and the smallest ( $e_{\min}$ ) Distance of the object from the lens at which the image can just be considered sharp.
- Enter the measured values in Table 1 in the report.

## Procedure (3/3)

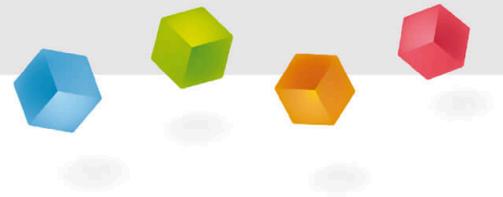
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Shifting the screen

- Bring the object back to the 18 cm mark and exchange the aperture for the pinhole with  $d = 5 \text{ mm}$ . Focus the image by moving the screen and take the same measurements as before. Record the measurements in Table 1 in the report.
- Repeat the measurements with the pinhole with  $d = 3 \text{ mm}$ . Also enter these measured values in Table 1 in the report.
- Switch off the power supply unit.

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# Report

Table 1

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Write down your observations in the table. Then calculate the depth of field  $S$  of the camera model when using the individual apertures.

**Fades**   **Distance  $e$  of the object from the lens**   **Depth of field**

$d$ [mm]	$e_{\max}$ [mm]	$e_{\min}$ [mm]	$S$ [mm]
20			
5			
3	<input type="text"/>	<input type="text"/>	<input type="text"/>
	<input type="text"/>	<input type="text"/>	<input type="text"/>
	<input type="text"/>	<input type="text"/>	<input type="text"/>

## Task 1

PHYWE

What is the relationship between the size of the aperture and the depth of field?

- The smaller the aperture, the greater the depth of field.
- There is no correlation between aperture and depth of field.
- The smaller the aperture, the shallower the depth of field.

✓ Check

## Task 2

PHYWE

What is the relationship between the size of the aperture and the brightness of the image?

- The smaller the aperture, the greater the image brightness.
- The smaller the aperture, the lower the image brightness.
- There is no correlation between aperture and image brightness.

✓ Check

## Task 3

PHYWE

What must be done to ensure that the film is sufficiently exposed at a small aperture?

- You have to refocus the image.
- You have to expose the film longer.
- You have to expose the film for a shorter time.

 Check

Slide	Score/Total
Slide 20: Aperture and depth of field	0/1
Slide 21: Aperture and image brightness	0/1
Slide 22: Exposure time	0/1

Total  0/3 Solutions Repeat Export text