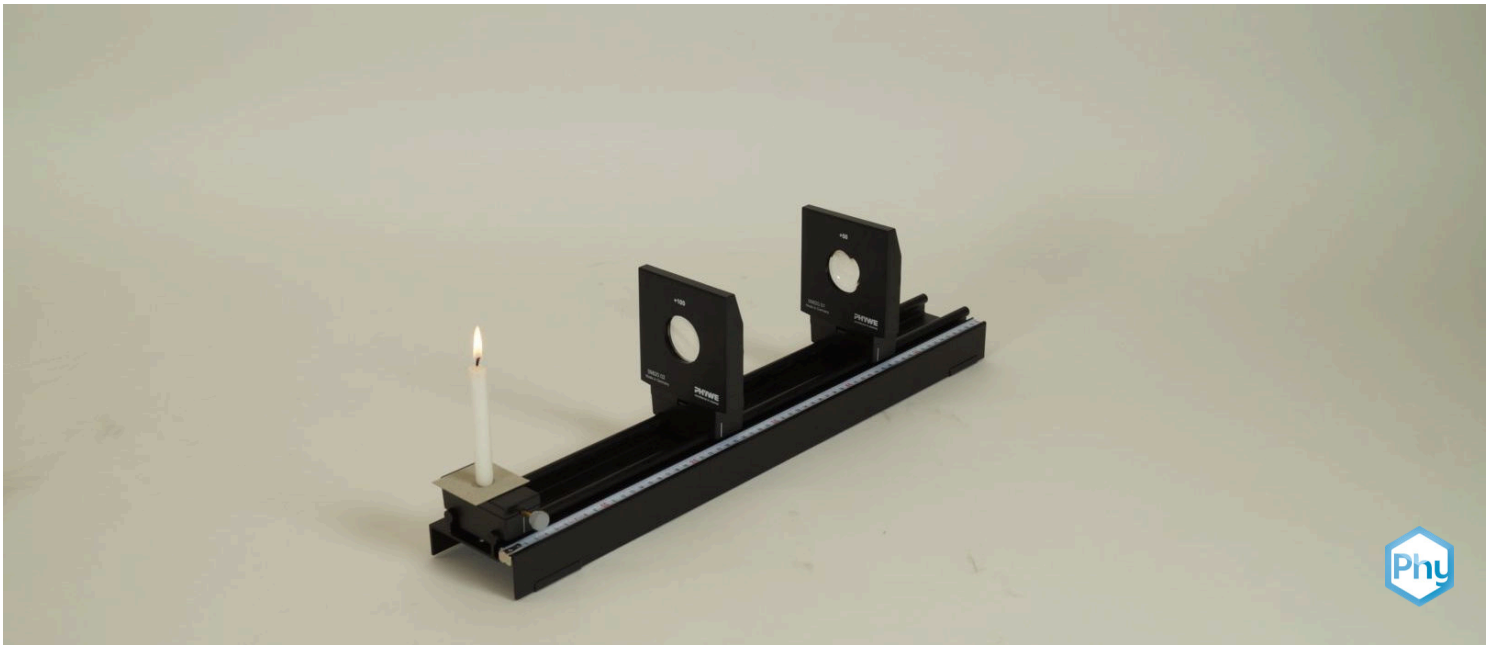
The Galilean telescope



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/62dd7974318b270003e217bb

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Teacher information

Application

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Experimental setup

A Galilean telescope allows the viewing of distant objects that appear closer and magnified by the optical instrument. The magnification is created with the help of several lenses.

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Other teacher information (1/4)

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Principle

A Dutch telescope (Galilean telescope) consists of two components: a converging lens as objective and a diverging lens as eyepiece, which produces a virtual, upright and laterally correct image.

Learning objective

Students will learn about the construction and function of a Dutch telescope and observe its optical effect.

Other teacher information (2/4)

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Task

- Students should build a model of a Dutch telescope and investigate how its parts work together.

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Other teacher information (3/4)

- If both the astronomical and the Dutch telescope are to be dealt with in physics lessons in this order, then it is advisable to carry out similar experiments on them and to compare the two types of telescope. This has been taken into account in the conception of this experiment.
- **Remark:** The Dutch telescope was used and described by Galileo. That is why it is also called the Galilean telescope. In 1610, Galileo discovered the mountains on the moon with such a telescope. It is the oldest telescope. The Dutch glass grinder Lippershey demonstrated it to the experts of the time in 1608. Because of its handiness due to the much shorter tube length compared to the astronomical telescope, it is used as opera glasses.

Other teacher information (4/4)

Notes on set-up and procedure

- In the second part of the experiment, when the students point the telescope model at a relatively distant object, it is recommended that they hold the optical bench with one hand and use the other hand to adjust the focus.
- To avoid damage to the lenses, the teacher should ask the students to connect the parts of the optical bench as tightly as possible beforehand and to handle the lenses with care.

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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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Observatory telescope

A Dutch telescope, also called a Galilean telescope, allows the viewing of distant objects that appear closer and magnified through the optical instrument.

How is the astronomical telescope constructed and how does it work?

Tasks

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Experimental setup

- Build a model of a Dutch telescope 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	Lens on slide mount, f=+100mm	09820-02	1
3	Lens on slide mount, f= -50mm	09820-06	1
4	Slide mount for optical bench	09822-00	1
5	Table with stem	09824-00	1
6	Screen, white, 150x150 mm	09826-00	1
7	Stearin candles, d 13mm, 20 pcs	09901-02	1

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Structure (1/2)

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- Set up the optical bench with the two tripod rods and the variable tripod foot.
- Place the scale on the front tripod rod.

Structure (2/2)

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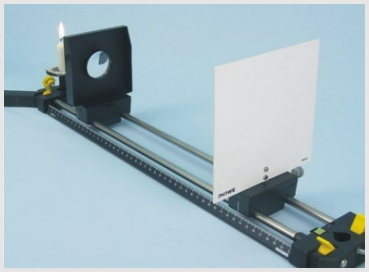

- Using the left part of the tripod base, attach the table with stem, place the candle on it and light it.
- Place the screen at 45 cm and the lens $f = +100\,\mathrm{mm}$, which forms the objective of the telescope, at about 10 cm onto the optical bench.

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Procedure (1/3)

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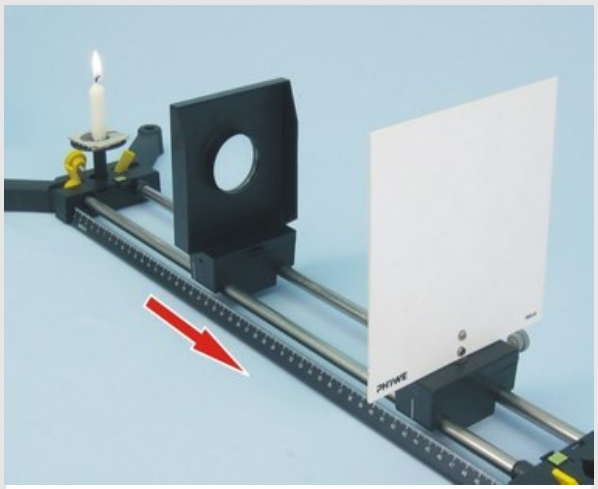

Displacement of the lens

- Move the lens, which is the objective of the telescope, to the right until a sharp image of the candle flame appears on the screen.
- Adjust a little if the candle flame is not in the optical axis.
- Note in the report where the image produced by the lens is located and what its properties are.

Procedure (2/3)

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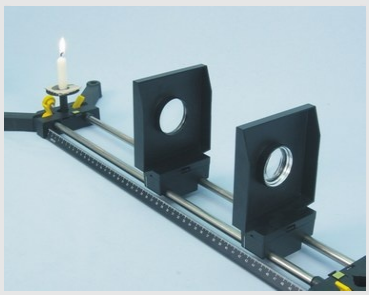

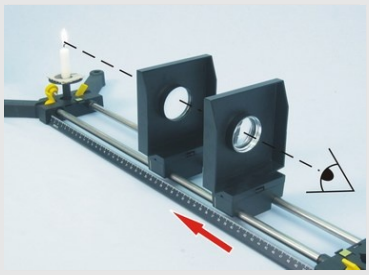

- Remove the screen, put the lens in place with $f = +50\,\mathrm{mm}$which forms the eyepiece of the telescope, at a distance of about 10 cm to the right of the objective.
- Look through the eyepiece and move it towards the objective until you get a sharp image of the candle flame.
- Note the characteristics of the image produced by the Dutch telescope. Also note the location of the eyepiece now.
- Extinguish the candle and take it with the table from the optical bench.

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Procedure (3/3)

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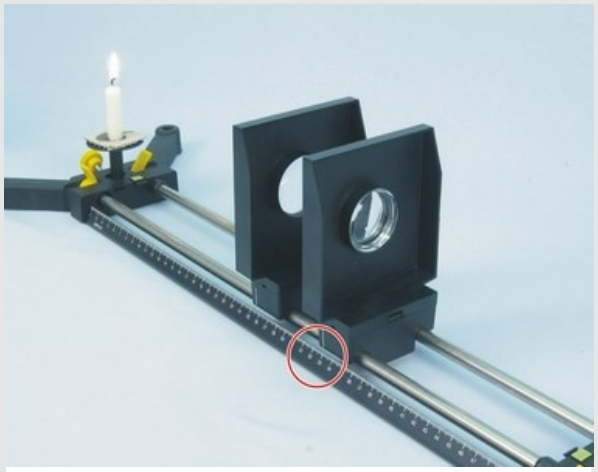

Measurement of the distance between the two lenses

- Point the telescope model at an object several metres away that is bright enough (window cross, curtain, roof of the neighbour's house, or similar) and move the lenses against each other until the image is sharp.
- Because of lens aberrations that cause distortion of the image, you should concentrate on sections of the image that are in the close vicinity of the optical axis.
- Measure and note the distance l that the two lenses (the objective and the eyepiece) have when the image of the distant object is in focus.
- Note the focal lengths of the objective and eyepiece in the protocol.

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Report

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Table 1

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Write down your measurement results in the table.

Sizes	Measured values
Distance between objective and eyepiece [cm]	
Focal length of the lens f_1 [mm]	
Eyepiece focal length f_2 [mm]	

Task 1

PHYWE

What are the properties of the image produced by the lens?

- ○ It is an upright, enlarged and real image.
- ○ It is an upright, enlarged and virtual image.
- ○ It is an upright, reduced and virtual image.

Check

What is the position of the image produced by the lens?

- ○ The image is between the single and double focal length of the lens.
- ○ The image is within the single focal length of the lens.

Check

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Task 2

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What are the properties of the image produced by the Dutch telescope?

- It is an upright, reduced and virtual image.
- It is an upright, enlarged and virtual image.
- It is an upright, enlarged and real image.

Check

What is the position of the eyepiece?

- It is within the single focal length of the lens.
- It is located between the single and double focal length of the lens.

Check

Task 3

PHYWE

What is the relationship between the distance l of the lenses and the focal lengths f_1, f_2?

- The distance between the two lenses l is about the same as the focal length of the lens: $l = f_1$.
- The following relationship exists between the distance between the lenses and the focal lengths: $l = f_1 - |f_2|$.
- The distance between the two lenses is about the same as the focal length of the eyepiece: $l = f_2$.

Check

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Task 4

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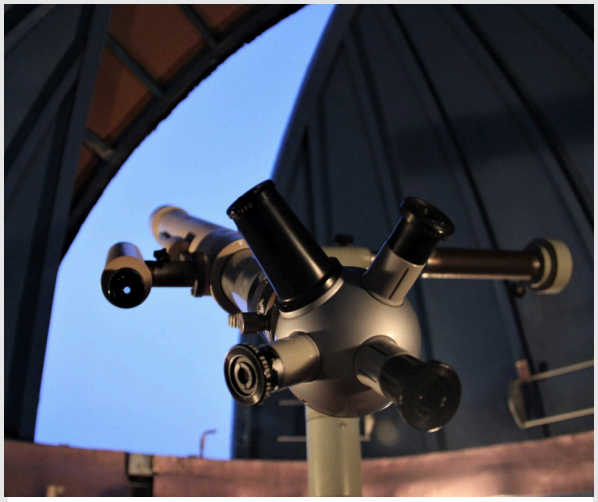
Does the Dutch telescope also have an intermediate image?

- ○ In the Dutch telescope, there is an intermediate image that is magnified through the eyepiece, as in the astronomical telescope.
- ○ In the Dutch telescope there is no intermediate image because the eyepiece is within the single focal length of the objective.

Check



Astronomical telescope

Task 5

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In the practical version of a Dutch telescope, the objective and the eyepiece are mounted at the ends of a tube of adjustable length. The text below describes the construction and operation of an astronomical telescope.

Fill in the missing words.

A Dutch telescope consists of a converging lens of large focal length, the _____, and a _____ of small focal length, the eyepiece, mounted on the _____ of a tube of adjustable length. Before the rays of light passing through the objective and emanating from the object can produce an intermediate image, they are deflected from their direction by the diverging lens, so that an upright, magnified and _____ image is produced.

Check

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Task 6

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What advantages does the Dutch telescope have over the astronomical telescope? Fill in the missing words.

While the astronomical telescope produces inverted images, the Dutch telescope produces [ ] images. Moreover, the Dutch telescope can be built much shorter, because its [ ] only has to be equal to the [ ] of the absolute focal lengths of the objective and the eyepiece. The tube length of the astronomical telescope must be equal to the [ ] of the focal lengths.

Check

Slide	Score / Total
Slide 19: Multiple tasks	0/2
Slide 20: Multiple tasks	0/2
Slide 21: Lens spacing	0/1
Slide 22: Intermediate image	0/1
Slide 23: Construction of the telescope	0/4
Slide 24: Advantages of the telescope	0/4
Total	**0 / 14**

Solutions Repeat Export text

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