7.6 Determination of the magnification of a telescope

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Printed: Nov 1, 2013 1:06:11 PM
interTESS (Version 13.06 B200, Export 2000)

Task

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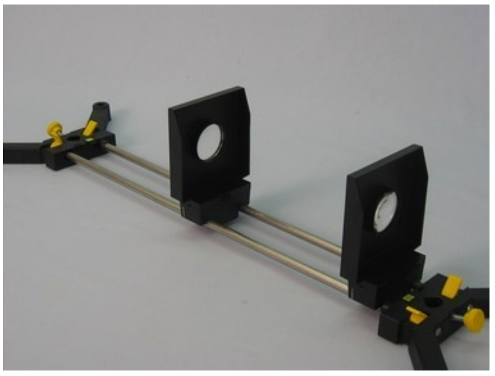
Construct a model of the astronomical telescope and determine the achievable magnification.



Use the space below for your own notes.

Logged in as a teacher you will find a button below for additional information.

Additional Information

This experiment can immediately follow an experiment on the construction and function of an astronomical telescope.

If this experiment is performed on its own, it can easily be expanded by using the lens with $f = -50$ mm (no. 09820.06) as ocular, instead of the lens with $f = +50$ mm. Then the magnification of a Dutch telescope can also be determined.

Note

A system of 10 lines with a length of 30 cm each and distances of 5 cm in between needs to be drawn on the blackboard before the start of the experiment. This will be observed by the students through the telescope model.

Remarks

The use of a diaphragm to limit the field of vision was avoided deliberately in order to keep the experiment as straightforward as possible.

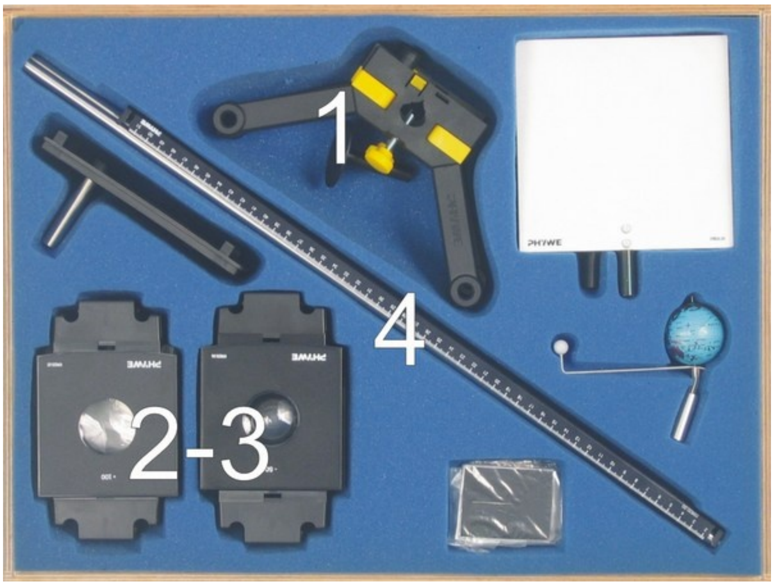
It could be a possible extension of the experiment, e.g. in view of providing the basis for question 3.

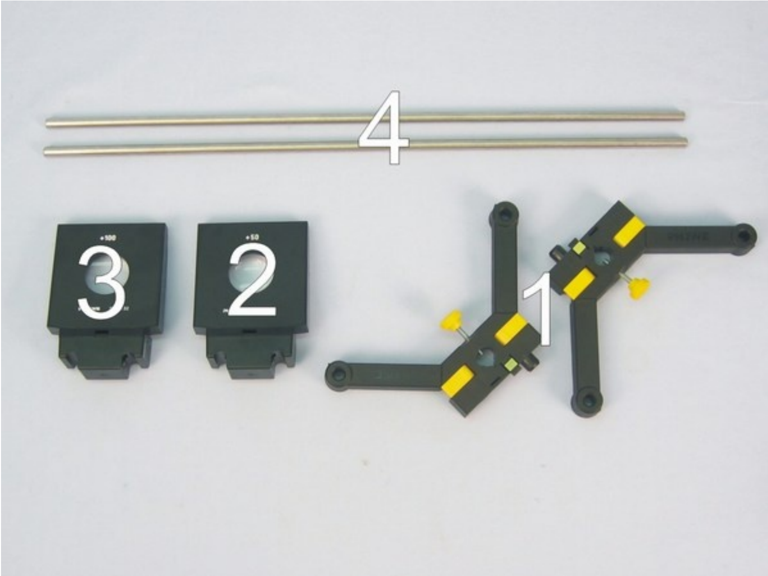
Material

Material from "TESS-Optics OE 2" (Order No. 13277.88)

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Lens on slide mount, $f = +100$ mm	09820-02	1
3	Lens on slide mount, $f = +50$ mm	09820-01	1
4	Support rod, stainless steel 18/8, $l = 600$ mm, $d = 10$ mm	02037-00	1

Material required for the experiment




4
3
2
1
+100
+50

Setup

On the blackboard there is a system of ten lines of 30 cm length each and a distance of 5 cm apart.

Using the two support rods and the variable support base (Fig. 1), assemble the optical bench (Fig. 2). Ensure that all parts are firmly attached to each other.


Fig. 1


Fig. 2

Position the lens with f = +50 mm (the ocular) at the end of the optical bench and the lens with f = +100 mm (the objective) about 20 cm away from the ocular (Fig. 3).

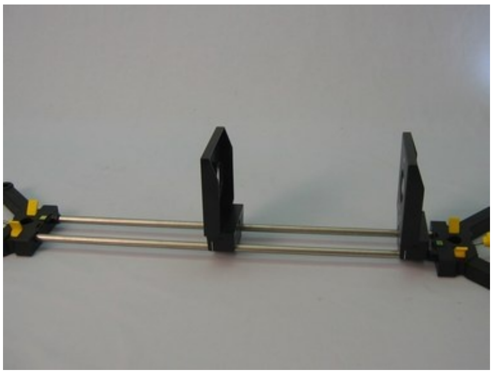


Fig. 3

Action

Aim the telescope model at the blackboard, which should be at least 4 to 5 meters away.

Move the objective until you see a focused image of the system of lines on the blackboard through the ocular (Fig. 4).

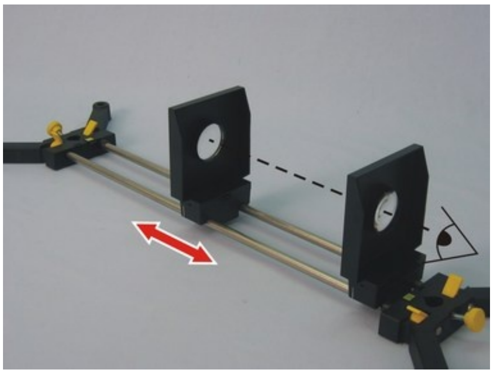


Fig. 4

Look through the telescope with your right eye and past the ocular with your left eye at the system of lines on the blackboard.

With a little practice you can see both systems of lines (the one on the blackboard and its image in the telescope) at the same time.

After careful observation, determine how many 5 cm line spaces on the blackboard correspond to the distance between two lines in the image from the telescope. Note your value on the Results page.

Results

The distance between two lines in the telescope image corresponds to [ ] line spaces on the blackboard.

The distance between two lines in the telescope image corresponds to about two line spaces on the blackboard.

Evaluation

Question 1:

What is the magnification achieved by the telescope model which you have constructed?

The telescope model achieves a magnification of about 2.

Question 2:

For the magnification M of an astronomical telescope it is true that

$M = f_1 \,/\, f_2$,

where f_1 is the focal length of the objective and f_2 is the focal length of the ocular.

Using this equation, calculate the magnification of your telescope model:

$M =$

Does your result agree with the experimentally determined value?

$M = f_1 / f_2 = 100 \text{ mm} / 50 \text{ mm} = 2$

The calculation gives a magnification of 2, which is in agreement with the experimentally determined value.

Question 3:

What would the advantages and disadvantages be in terms of image quality if a diaphragm were to be brought into the light path?

The image would be less distorted (more in focus), but it would also be dimmer.

Question 4:

In large observatories, astronomical observations are made using *reflecting telescopes*. These have large concave mirrors as objectives in place of convergent lenses. Can you explain why?

For telescopes used in astronomical observations one needs large objectives, in order to obtain images which are as bright as possible. Producing flawless lenses of that size is much more difficult (and hence expensive) than producing large concave mirrors.