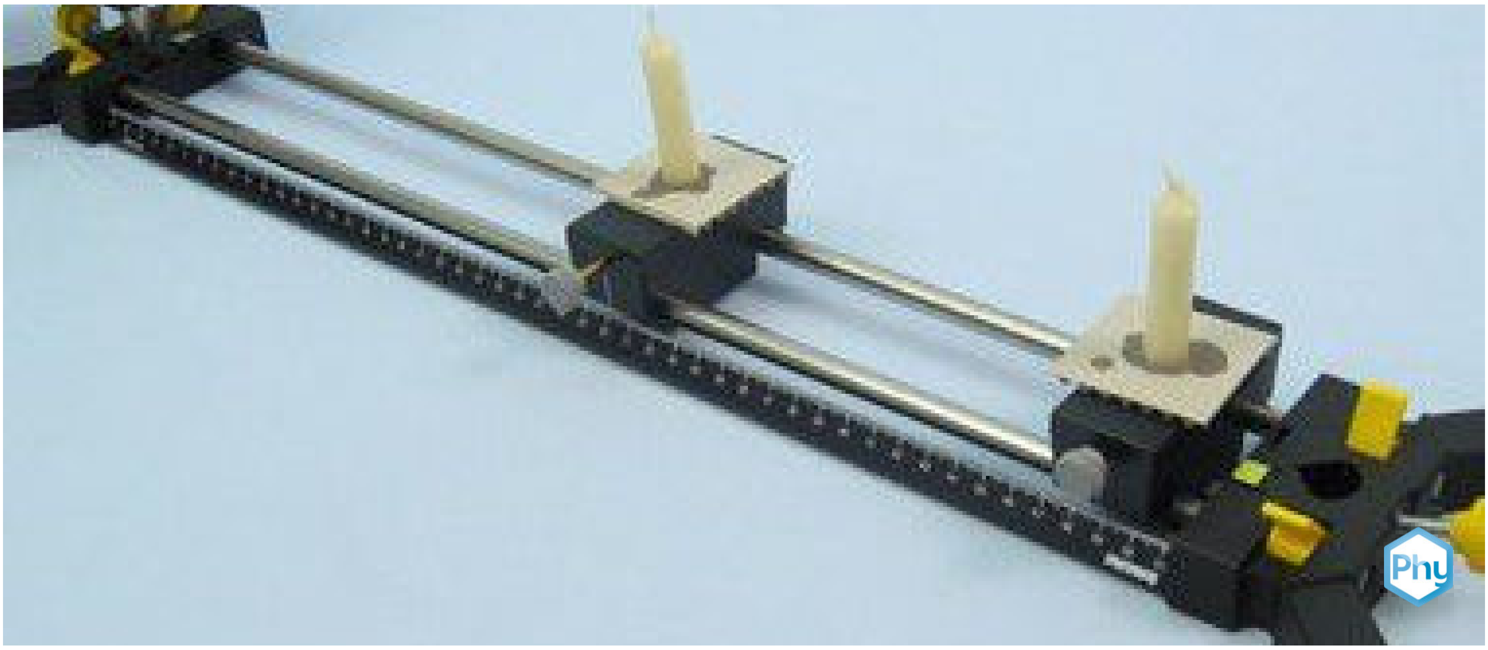
Luminous intensity (photometer)



Physics | Light & Optics | Dispersion of light

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/62db9ff9a52f910003dffb36

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Teacher information

Application

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Experimental setup

Luminous intensity is a fundamental quantity in physics and describes the incident luminous flux on a solid angle. Luminous intensity can therefore be used to quantitatively compare a wide variety of light sources, such as LED lamps.

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Other teacher information (1/4)

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Principle

The photometer is used to determine the luminous intensity I of a light source. If no image is visible on the photometer, the illuminance E of the light source to be examined is equal to the illuminance of the reference light source. Since for the illuminance $E = I/r^2$ is valid, one can use the distances to the photometer r to measure the ratios of the light intensities.

Learning objective

Students should understand the relationship between luminous intensity and illuminance by experimenting with light sources of different strengths. This will practice the safe use of an optical bench and an electric light source.

Other teacher information (2/4)

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Task

1. The students observe the cut-out figure on the photometer(screen) and move the photometer so that the figure is no longer visible from either direction.
2. The resulting distances between light source and photometer, and comparison light source and photometer are entered by the students in a table.
3. The measurement of the distances is repeated for an electric light source with two different voltages.

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Other teacher information (3/4)

The experiment, which has to be carried out in a completely darkened room, is demanding both in terms of the students' experimental skills and their care and accuracy in observing.

Note

The relationship between the luminous intensity I, the illuminance E and the distanceand r is in equation form $I = E \cdot r^2$. It was deliberately not dealt with, as the experiment cannot provide sufficient knowledge for this.

On the equation for luminous intensity, the units candela (cd) and lux (lx) for I or E and the unit light source used in physics must be dealt with in further physics lessons.

Other teacher information (4/4)

Notes on set-up and procedure

The construction of the photometer is relatively time-consuming. In order to gain time for experimenting, it is advantageous for interested pupils to cut out the squares from paper, assemble them as required and connect them with transparent adhesive tape, following the teacher's instructions.

Draughts must be avoided while working with the photometer.

The students' measurement results can vary considerably. They differ especially if the candle flames or the candle wicks are of different sizes or if the flame of the comparison light source changes during the measurements and thus other distance ratios occur.

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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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Energy-saving lamp

In everyday life, it is difficult to compare two different light sources, such as a candle and an electric lamp, in terms of their brightnesses. This is because the distance to the light source also plays a role. That is why the physical quantity *Light intensity* was introduced, which enables a comparison between different light sources.

When buying an LED lamp, it is also important to pay attention to the indication of the luminous intensity, because this quantity reveals how much light arrives at which point.

Tasks

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Experimental setup

1. Observe the cut-out figure on the photometer(screen) and move the photometer so that the figure is no longer visible from either direction.
2. Then measure the distances between the light source and the photometer and the reference light source and the photometer and enter them in the table.
3. Repeat the measurement of the distances for an electric light source with two different voltages.

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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	Diaphragm with hole, d=20mm	09816-01	1
5	Slide mount for optical bench	09822-00	2
6	Mount with scale on slide mount	09823-00	1
7	Diaphragm holder, attachable	11604-09	1
8	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
9	Stearin candles, d 13mm, 20 pcs	09901-02	1

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Set-up (1/5)

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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 (2/5)

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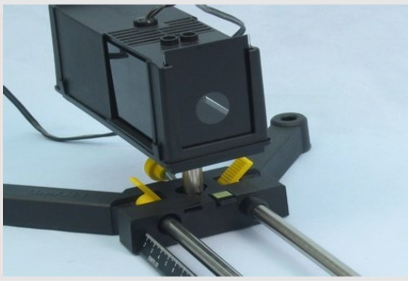
- Clamp the light box in the left part of the tripod base so that the lens side faces away from the optical bench.
- Slide a translucent screen in front of the lens and the pinhole into the shaft at the other end of the light.



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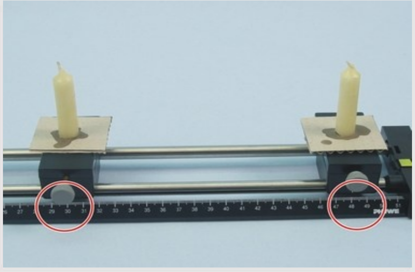
Set-up (3/5)

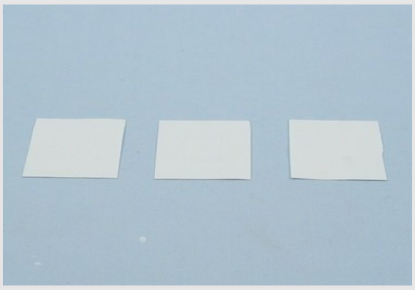
- Attach the candles to cardboard discs.
- Place the one candle on one of the slides at the 50 cm mark on the optical bench. This candle is to be the comparison light source in the following experiment. K_V .
- Place the other candle (K) with the second slide at the 30 cm mark.

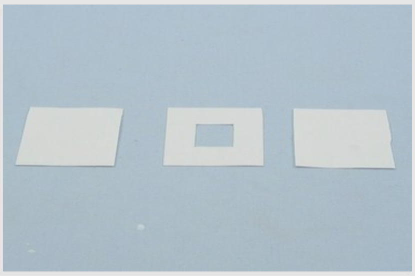


Set-up (4/5)

Now build a photometer:

- Cut out 3 squares with sides 50 mm long from the white paper.
- Cut out an area in the middle of a square (a square or a circle, a star, a Christmas tree, a Chinese dragon or similar).





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Set-up (5/5)

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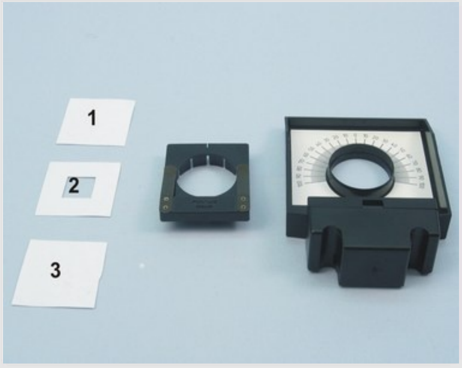
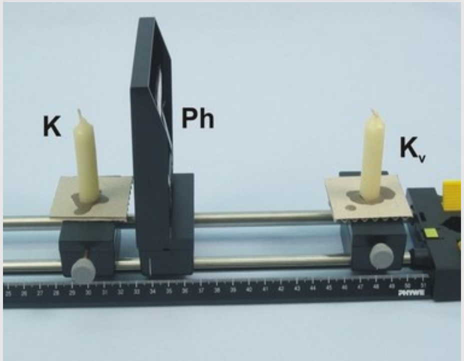
- Place the square with the cut-out figure between the other two, put the whole thing on the aperture holder and slide it onto the socket with scale.
- Place the photometer made in this way on the optical bench near the candle.





Procedure (1/4)

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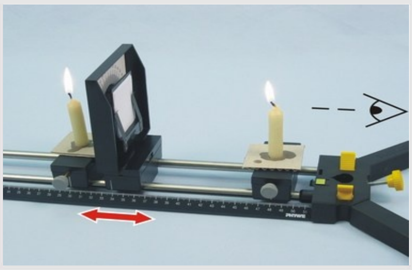
- Light both candles.
- Look over the candle K_V onto the photometer. You will clearly see the figure you cut out of the white paper.
- Move the photometer until you can no longer see the figure.



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Procedure (2/4)

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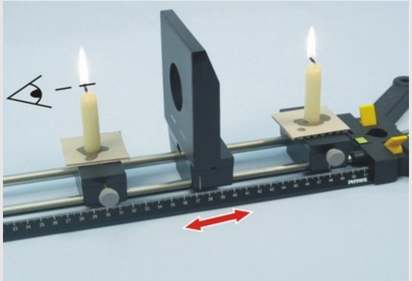
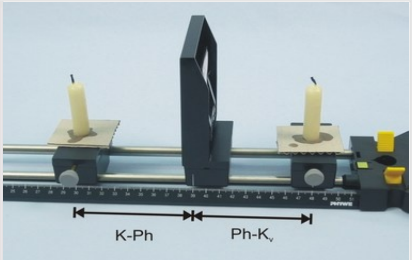
- Look away from the candle K onto the photometer and move it until you see the figure on the photometer of K *and* K_V. from the outside.
- Blow out the candles.
- Measure the distances of the candle K from the photometer and the photometer from the candle K_V. Enter the distances in Table 1.





Procedure (3/4)

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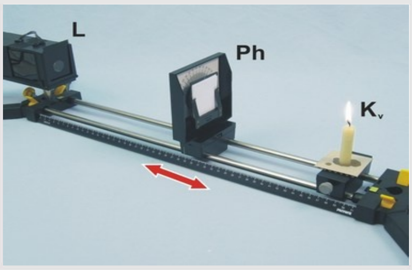
- Take the candle K from the optical bench.
- Connect the lamp to the power supply unit (6 V ~) and switch it on.
- Light the candle K_V again and examine the brightness of the lamp of the luminaire (L).
- Move the photometer until the figure on the photometer has disappeared from L and K_V .



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Procedure (4/4)

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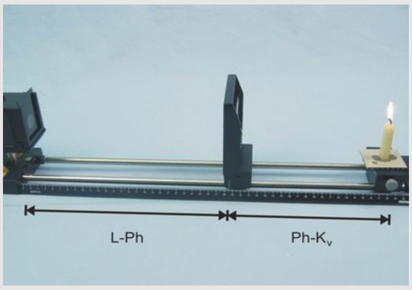
- Measure the distances luminaire - photometer and photometer - candle K_V Note them down in the table in the protocol.
- Connect the luminaire to 12 V ~ and carry out the same measurement as for 6 V ~. Note the measurement results in the table in the protocol.
- Extinguish the candle K_V and switch off the power supply unit.



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Report

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Table 1

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Enter your measurements in the table.

Light source unknown Brightness	Distance of the photometer from of the reference light source [cm]	Distance light source unknown Brightness from photometer [cm]
Candle		
Lamp, 6V		
Lamp, 12V		

Task 1

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In physics, the quantity illuminance E is used to measure brightness. If the figure is not visible on the photometer, then the illuminance with respect to the light source under examination is equal to the illuminance with respect to the reference light source. The distances of the light sources from the photometer are different if the light sources are of different strengths. In physics, the quantity luminous intensity I is used to capture these relationships.

Which statements are correct?

- ☐ The greater the illuminance and the distance, the greater the luminous intensity.
- ☐ The smaller the exposure and the distance, the larger the light size.
- ☐ The greater the luminous intensity and the smaller the distance, the greater the illuminance.

Check

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Task 2

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What can you say about the luminous intensity of the light sources listed in the table (1st column) compared to the luminous intensity of the reference light source K_V?

- ☐ The luminous intensity of the lamp at 6 V is greater than the luminous intensity of the comparison light source, and the luminous intensity of the lamp at 12 V is even greater.
- ☐ The luminous intensity of the lamp at 6 V is (almost) the same as the luminous intensity of the comparison light source, and the luminous intensity of the lamp at 12 V is greater.
- ☐ The luminous intensity of the candle K is (almost) as great as the luminous intensity of the reference light source, the candle K.

Check

Slide	Score / Total
Slide 23: Relationship between luminous intensity and illuminance	**0/2**
Slide 24: Different light intensities	**0/2**

Total 0 / 4

Solutions Repeat Export text

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