Inverse square law with Cobra SMARTsense

Physics | Light & Optics | Dispersion of light

Difficulty level	Group size	Preparation time	Execution time
-	-	-	-

This content can also be found online at:

http://localhost:1337/c/605082731d5969000384ba13

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Teacher information

Application

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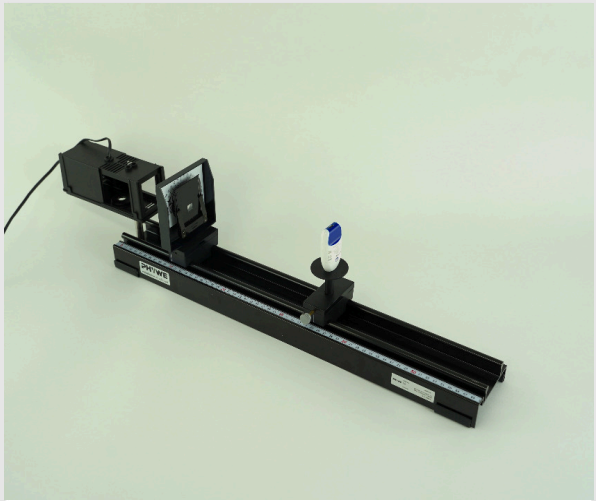

Experimental set-up

The strength of an illumination decreases as one moves away from the light source. The correlation between illuminance and distance from the light source is described by the inverse square law. This makes it possible, for example, to determine the distance of stars.

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Other teacher information (1/3)

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Scientific principle

The radiation of a light source diverges. The divergence is described by the inverse square law, which states that the illuminance decreases inversely proportional to the square of the distance.

Learning objective

Students are to learn about the inverse square law.

Other teacher information (2/3)

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Task

The students should use the *Cobra SMARTsense* sensor to investigate how the illuminance decreases when the sensor is moved away from the light source.

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Other teacher information (3/3)

- The inverse square law is $E = \frac{I}{r^2}$, whereby I is the luminous intensity of the light source and E is the illuminance that is observed with a distance of r from the light source.

Notes on structure and procedure

- The actual sensor of the Cobra SMARTsense device is located at the upper edge and must be fully illuminated for correct measurement. Since the aperture is only one

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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Lighthouse at night

The strength of an illumination decreases as one moves away from the light source. The correlation between illuminance and distance from the light source is described by the inverse square law. This makes it possible, for example, to determine the distance of stars.

How is the inverse square law formulated?

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Tasks

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Experimental set-up

Investigate with the help of the *Cobra SMARTsense* sensor how the illuminance decreases as you move the sensor further and further away from the light source.

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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 square	09816-03	1
5	Slide mount for optical bench	09822-00	1
6	Screen, white, 150x150 mm	09826-00	1
7	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
8	Cobra SMARTsense - Light, 1 ... 128 kLx (Bluetooth + USB)	12906-01	1
9	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/2)

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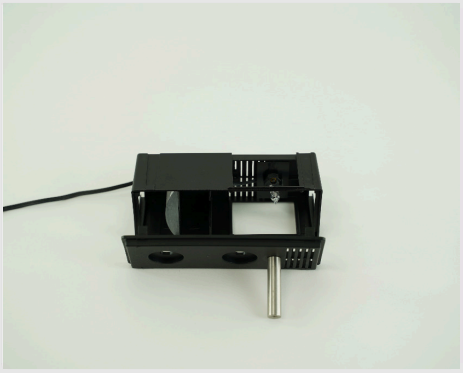
- Place the base with the stem under the light box.
- Clamp it into the left part of the tripod base so that the lens side faces away from the optical bench.



Set-up (2/2)

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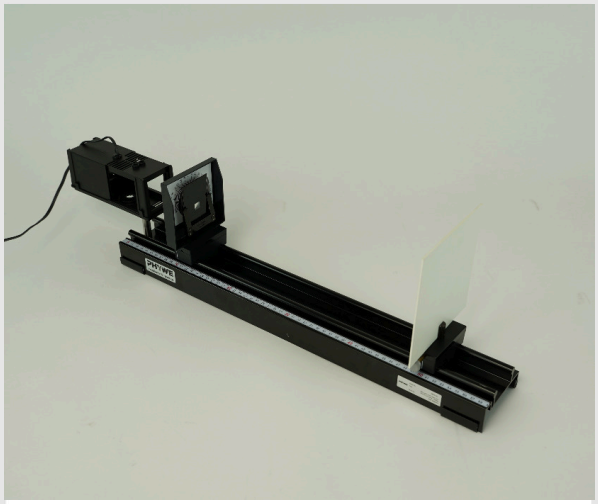

Optical bench with lamp, aperture and shade

- Slide an opaque aperture in front of the lens of the light.
- Place the shade on the optical bench at a distance of 50 cm from the light source.
- Slide the square aperture (10 mm x 10 mm) into the holder and place it on the mount with the scale, which you position on the optical bench at a distance of 10 cm from the light source.

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Procedure (1/5)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Procedure (2/5)

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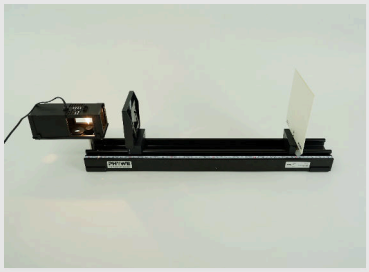

- Connect the lamp to the power supply unit (12 V~) and switch it on.
- Observe on the screen where the image of the square aperture is located.

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Procedure (3/5)

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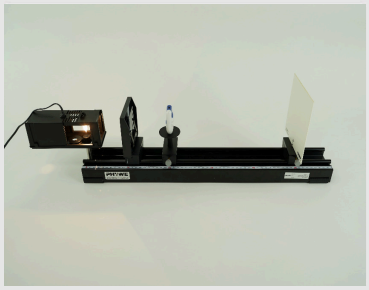

- Place the table with the stem 15 cm from the stem of the light box on the optical bench and position the sensor on the table so that it can measure the light beam transmitted by the aperture. You can easily see the correct positioning by the shadow of the sensor that is displayed on the screen.
- Now remove the screen from the optical bench.

Procedure (4/5)

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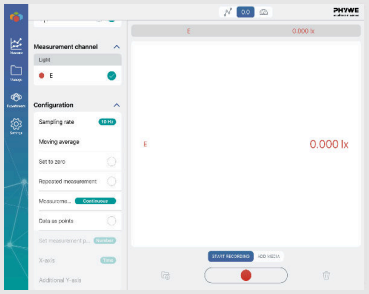

- Start the app and set the 'Cofiguration' to 'Continuous measurement'. You can read the value of the measured size by clicking on the '0.0' symbol, which is located in the middle of the top line.
- Move the sensor in 5 cm steps and measure the illuminance at each step until you have reached the 50 cm mark with the sensor. You should have taken 8 measurements.
- Note your results in Table 1.

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Procedure (5/5)

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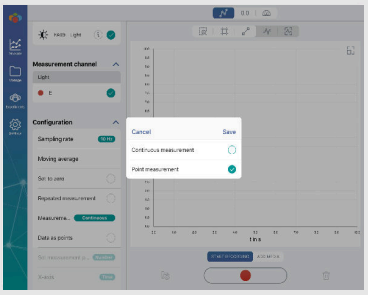

- Now start a new measurement by selecting the second measurement method 'Point measurment' in 'Configuration'.
- Set the sensor to the start position (at 15 cm) and move it to the right again. Measure the illuminance E at every 5 cm step.
- After you have finished the measurement, you can save the obtained graph with the folder icon in the bottom bar.
- Turn off the power supply.

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Report

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Table 1

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Enter your readings in the table.

Distance to light source [cm]	Illuminance [lx]
15	
20	
25	
30	
35	
40	
45	
50	

Task 1

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With the second measurement method you have plotted the illuminance graphically. How does the illuminance E depend on the distance to the light source r?

- ○ $E \sim -r^2$
- ○ $E \sim \frac{1}{r^2}$
- ○ $E \sim r$

Check

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Task 2

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Lighthouse at night

The inverse square law is: $E = \frac{I}{r^2}$, whereby I is the luminous intensity of the light source. The beacon of a lighthouse has a luminous intensity of $I = 25\,\mathrm{Mcd}$ (25 Mega Candela). You stand on a ship and measure an illuminance of $E = 1\,\mathrm{lx}$.

How far are you from the lighthouse?

- ○ The distance between the lighthouse and the ship is $r = 10\,\mathrm{km}$.
- ○ The distance between the lighthouse and the ship is $r = 5\,\mathrm{km}$.
- ○ The distance between the lighthouse and the ship is $r = 25\,\mathrm{km}$.

Check

Slide	Score / Total
Slide 20: Proportionality	0/1
Slide 21: Distance determination	0/1
Total	**0 / 2**

Solutions | Repeat | Export text

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