Shadows (umbra and penumbra)

Physics | Light & Optics | Dispersion of light

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4da642ce572a000382d76e

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Teacher information

Application

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Shadows?

When objects are illuminated by a light source, they cast shadows.

But is this image a shadow?

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Other teacher information (1/3)

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Prior knowledge

The students should know that light propagates in a straight line from the source to the receiver. If they hit an object on their way, it casts a shadow.

Scientific principle

Using the light box, different objects are illuminated from different directions and the shadows are observed.

Other teacher information (2/3)

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Learning objective

In the first part of the experiment, the students should observe the formation of shadows behind an illuminated object and draw conclusions about the conditions of shadow formation and the properties of light propagation.

In the second part of the experiment the students get to know the umbra and penumbra. However, both experiments can also be carried out independently of each other. By using colour filters, the students can observe an interesting and surprising phenomenon in an additional experiment: the formation of coloured shadows.

Tasks

1. Investigation of shadow formation behind an illuminated object
2. Investigation of shadow formation under illumination of two light sources

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Other teacher information (3/3)

Since two light sources are not available to create the core and penumbra of an object, a simple method of light division with a mirror is used. The mirror on a block is placed in portrait format for this purpose. It should be placed as close as possible to the opening so that a wide cone of light is generated. In any case, when placing the opaque object on the block, make sure that it is within the light cone of the mirror.

The method of light division, however, represents a possible barrier to the students' cognitive process. Another possibility is to use a small candle as a second light source.

Safety instructions

- Halogen lamps become warm during prolonged use
- Avoid looking directly into the light source

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Student Information

Motivation

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Every object casts a shadow when it is illuminated. Sometimes it is very long, sometimes rather short. Why is that and what happens when an object is illuminated from several sides? Think about the players in a football stadium with floodlighting.

In this exercise you will find answers to these questions.

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Tasks

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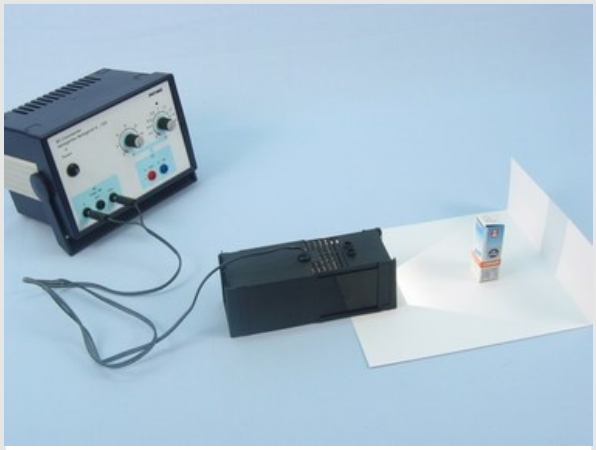

Experiment set-up

Where there is light, there is shadow!

1. Examine the shadowing behind an illuminated object.
2. Examine the shadow formation when the object is illuminated from two sides.

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Equipment

Position	Material	Item No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Mirror on block, 50 mm x 20 mm	08318-00	1
3	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
4	Colour filter set, additive (red, blue, green)	09807-00	1

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Additional equipment

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Position	Material	Quantity
1	transparent film (approx. 8 cm x 8 cm)	1
2	White paper (DIN A4)	1

Set-up

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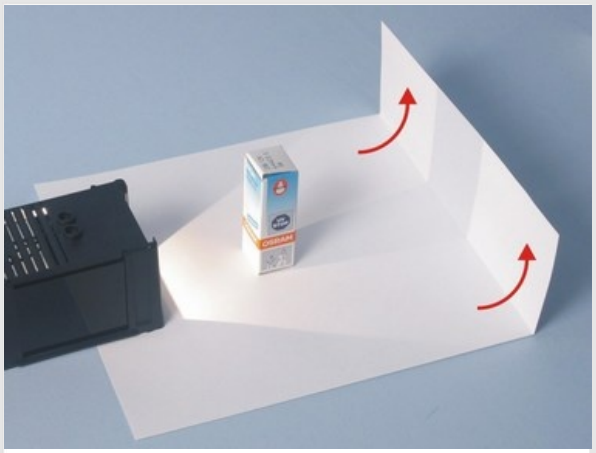

Experiment set-up

Place the light box with the lamp side on a white sheet of paper. Fold the sheet so that a screen is created. Place an opaque body (e.g. light bulb package) in front of the lamp.

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Procedure (1/5)

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Connecting the light box

1. shadow formation with a light source

- Connect the light box to the power supply unit (12 V ~)

Procedure (2/5)

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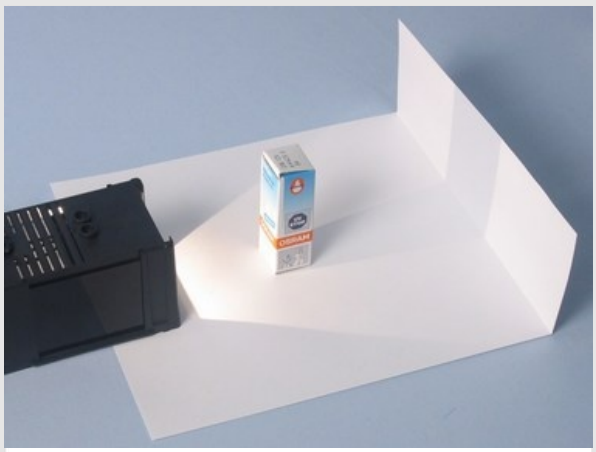

Shading

- The opaque body should be about 10 cm away from the light box. Observe the area behind the body and on the paper surface.
- Note your observations in the minutes.

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Procedure (3/5)

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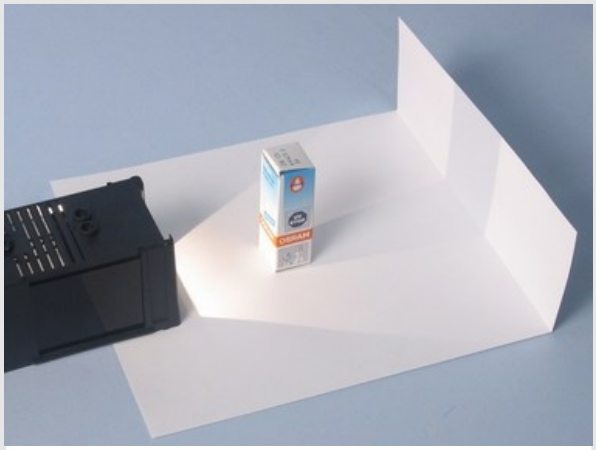

Move the object

- Now move the opaque body closer to the light source and then remove it.
- How does the shadow change?
- Note your answers in the minutes.
- Instead of the opaque body, hold the piece of film in the light path. What happens?
- Note your observations in the minutes.

Procedure (4/5)

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Preparation

2. shadow formation with two light sources

- Remove one of the dense panels from the light box. Place the mirror with the mirror surface facing forward on the side of the light box. Connect the light box to the power supply unit (12 V ~).
- Position the opaque body so that it is in the light cone of the mirror.
- Observe the area behind the body, then alternately cover a light well of the light box with the screen.
- Note your observations in the protocol in Table 1.

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Procedure (5/5)

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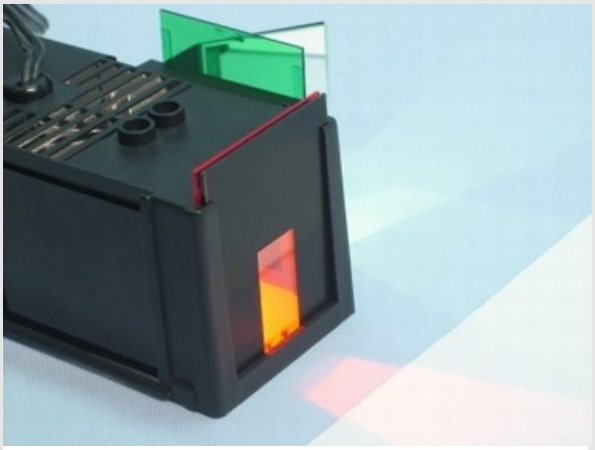

Coloured shadows

Additional task

- In the second partial test, push the red color filter into the middle light well and the green color filter into the side well.
- Observe again the shadow formation behind the opaque body.
- Alternately cover one light well of the light box and note your observations in the protocol in table 2.
- Swap the color filters. What can you see?
- Note your observations in the minutes.

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Report

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Task 1

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Write down your observations on shadow formation with a light source.

a) What do you observe behind the illuminated opaque object?

There is _____ of the object.

b) What do you observe behind the illuminated transparent object?

There is _____.

a shadow

no shadow

Check

Task 2

PHYWE

Note your observations when you change the position of the object?

(c) Object closer to the light source.

The shadow of the object becomes _____.

d) Object further away from the light source.

The shadow of the object becomes _____.

bigger

smaller

Check

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Table 1 and 2

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Lighting	Observation behind the illuminated object
with two light sources	
only with middle light source (lateral light shaft concealed)	
only with lateral light source (middle light shaft concealed)	

Filter color	Colour of the shadow area
red	
green	

Additional task 1

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Note your observations when swapping the color filters.

Fill in the text gaps.

When the [ ] are swapped, the [ ] of the [ ] changes accordingly.

Check

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Task 3

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Compare your observations with the first task.

Under what conditions does a shadow occur?

Only when an _____ is illuminated by a _____ does a _____ appear _____ the body.

behind
opaque body
light source
shadow

Check

Task 4

PHYWE

Connect the matching crosses on your hand to task 1 and hatch the shadow area.

How do the shadow edges run?
Try to justify your observations. What is the cause of this phenomenon?

The _____ are _____ because the _____ spreads _____.

straight
light
shadow edges
straight

Check

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Task 5

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Where does shadowing find its application? Give an example.

Examples

Task 6

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Compare your observations to the experiment with 2 light sources.

Every light source creates a _____ behind an _____ body. When two light sources illuminate such a body together, each one creates a _____. However, the two _____ _____ each other, creating _____ and a _____.

shadow
half-shadow areas
opaque
shadow
overlay
core shadow area
shadow areas

Check

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Additional task 2

Try to give a reason for your observations in the additional task.

The reason for these color appearances is the absorption of the green or red light by the _____ object and the simultaneous coloring of the respective _____ by the _____ of the respective other _____.

light source
obscure
half-shade area
light

Check

Slide	Score / Total
Slide 19: Shadow formation with light source	0/2
Slide 20: Change Position of the object	0/2
Slide 22: Changing the colour filters	0/3
Slide 23: Shadow creation	0/4
Slide 24: Shadow edges	0/4
Slide 26: Shadows with two light sources	0/7
Slide 27: Reason Colour appearances	0/4

Total amount 0 / 26

Solutions | Repeat | Exporting text

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