

# Subtractive colour mixing



In this experiment, the students learn about the second technically significant process of color generation, subtractive color mixing.

Physics

Light & Optics

Light & Colour



Difficulty level

medium



Group size

2



Preparation time

10 minutes



Execution time

10 minutes

This content can also be found online at:



<http://localhost:1337/c/616d5603aeb0ac0003430b07>

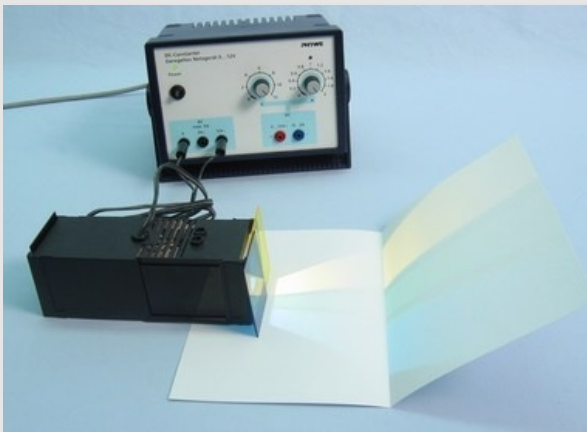
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## Teacher information

### Application

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Test setup

With this experiment, the pupils are to investigate the possibility of subtractive colour mixing, based on the different colour absorption of the filters. In this way, they learn about the second technically significant process of colour production.

The explanation of the dark to black color impression that can be observed when the color filters are arranged one behind the other serves to understand the content of the term absorption.

## Other teacher information (1/5)

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### Previous



A prerequisite for understanding the processes is knowledge of the color decomposition of white light, which is thus repeated and expanded.

### Principle



In the possible combination in the color hexagon, the overall connection of both processes of color production becomes clear. Between two additive primary colors there is a mixed color, which is also one of the subtractive primary colors. Between two subtractive primary colors is the additive primary color that results when white light falls through filters in the two subtractive primary colors one after the other.

## Other teacher information (2/5)

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### Learning



In this experiment, the students learn about the second technically important method of colour production, subtractive colour mixing.

### Tasks



The students investigate which colour impressions can be achieved by different combinations of colour filters in the light path of the light box.

## Other teacher information (3/5)

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### Notes on structure and implementation

The experiment can be carried out with little effort and without making any great demands on the students' experimental skills. When setting up the experiment, care should be taken to ensure that the side light shafts are closed. The tasks in the evaluation are graded in their degree of difficulty. The teacher can facilitate the solution of the problem question by using an older color picture negative given to the student. The further photographic path in colour positive development (reversal process and subtractive copy light control) is relatively difficult to grasp and should therefore only be offered if there is an existing interest.

In a first sub-experiment of this experiment, the students investigate the possibility of observing three different colours on the screen resulting from the partial overlapping of two colour filters. This paves the way for understanding the problem formulated as the initial question.

## Other teacher information (4/5)

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### Notes on implementation

The color impression subjectively observable in the preliminary experiment (view through the yellow color filter or through a filter combination from the window) can be discussed analogously in terms of content and conveys an understanding of the similarity between white incandescent light and the light emanating from the sun.

In the possible combination in the color hexagon, the overall connection of both processes of color production becomes clear. Between two additive primary colors there is a mixed color, which is also one of the subtractive primary colors. Between two subtractive primary colors is the additive primary color that results when white light falls through filters in the two subtractive primary colors one after the other.

## Other teacher information (5/5)

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### Note

The experiments on colour production can also be carried out in separate groups (one group investigates additive colour mixing, another the subtractive method). By presenting and discussing the results together afterwards, the differences between the two methods become clear. At the same time, the pupils are given the opportunity to explain their experiments and results to the other group of pupils in a physically correct and comprehensible way. In a follow-up lesson, the learning groups can be swapped in order to check the results.

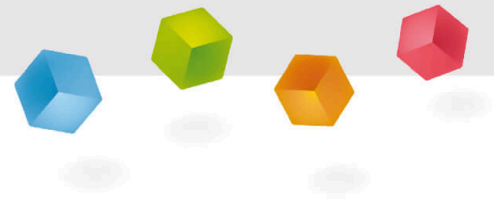
## Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.

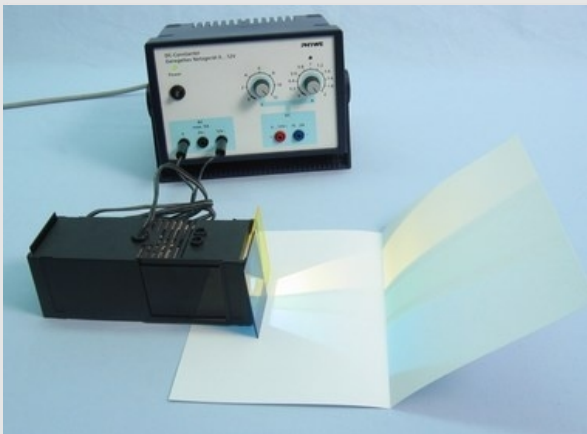
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## Student Information

### Motivation

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Test setup

In this experiment you will learn about subtractive color mixing. This is based on the different colour absorption of the filters. In this way, you will learn about the second technically important process of color generation.

A prerequisite for understanding the processes is knowledge of the colour decomposition of white light, which is thus repeated and expanded. The colour impression that can be subjectively observed in the preliminary experiment (view through the yellow colour filter or through a filter combination out of the window) can be discussed in class in terms of content and conveys an understanding of the similarity between white incandescent light and the light emitted by the sun.

## Tasks

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Why is the color negative so different from the original?

Investigate which color impressions can be achieved by different combinations of color filters in the light path of the light box.

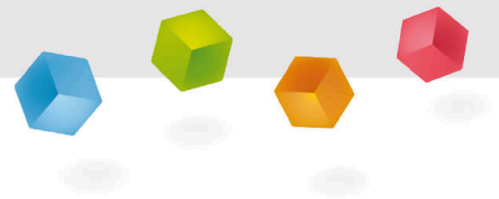
## Equipment

Position	Material	Item No.	Quantity
1	<a href="#">Light box, halogen 12V/20 W</a>	09801-00	1
2	<a href="#">Colour filter set, subtractive (yellow, magenta, cyan)</a>	09808-00	1
3	<a href="#">PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A</a>	13506-93	1



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# Structure and implementation



## Structure (1/2)

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### Preliminary test

Hold the yellow color filter in front of your eye and look out the window. What do you notice? Write down your observations. Add the cyan filter and look through both filters at the same time. What can you observe now?

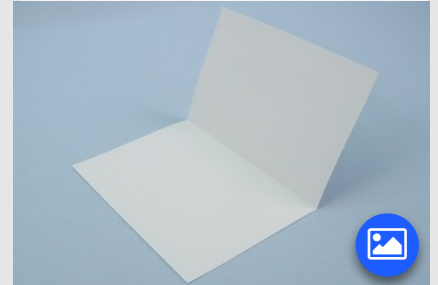
Note your observations in the log.

## Structure (2/2)

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### Main experiment

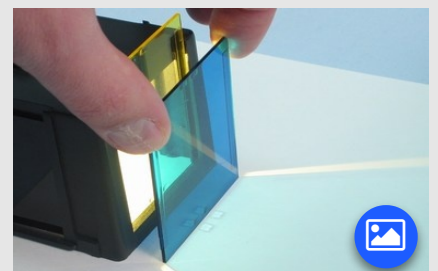
- Fold your sheet of paper once across the middle and fold the right half upwards as a screen. Write down your observations in the protocol.
- Place the light box with the lamp side at a distance of about 10 cm from the folding edge, like the one in the illustration below right. Make sure that the two openings on the sides of the light box are closed with the tightly closing shutters.



## Procedure (1/2)

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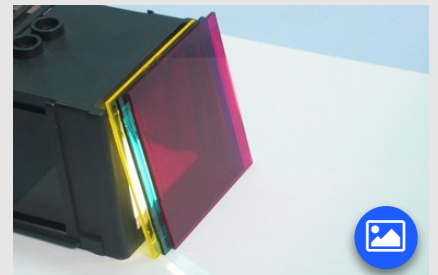
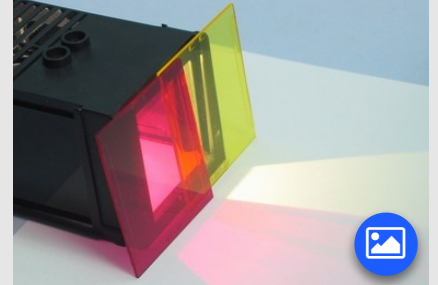
- Connect the light box to the power supply unit
- Insert the yellow colour filter into the light well on the lamp side. Observe the resulting colour impression on the screen and note your observations in the protocol.
- Hold the cyan filter directly in front of the yellow color filter. What can you observe? Repeat this partial experiment for the filter combination yellow-purple and cyan-purple. Write down your observations in the protocol.



## Procedure (2/2)

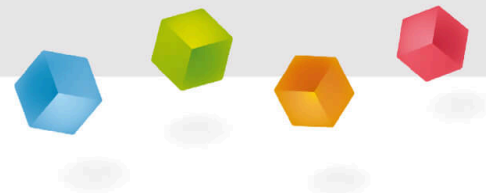
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- Change the set-up by holding the purple and the yellow colour filter outside the light well slightly overlapped in front of the light box. Note the colours visible on the screen.
- Repeat this for the other filter combinations (cyan-purple and cyan-yellow).
- Finally, hold all three colour filters simultaneously one behind the other in front of the light shaft. Write down your observations in the protocol.



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## Report



Task 1

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Write down your observations on the yellow color filter and the yellow and cyan color filter one after the other from the preliminary experiment:

Task 2 (1/2)

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Write down your observations in the table.

Test setup	Colors on the screen
Yellow color filter only	
<b>Color filters one after the other</b>	
Yellow and cyan	
Cyan and purple	
Yellow and purple	

## Task 2 (2/2)

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Write down your observations in the table.

Test setup	Colors on the screen
<b>Color filter overlapping:</b> Yellow and purple	
Cyan and purple	
Cyan and yellow	
All 3 color filters (one after the other)	

## Task 3

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Compare the observations with the colour filter combinations yellow-cyan and yellow-purple. According to this, which colors does the yellow filter also let through?

## Task 4

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The white light emitted by the light box is composed of the spectral colours red, orange, yellow, green, blue and violet.

Try to explain why behind a yellow filter in the light path only this color can be observed.

## Task 5

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Try to give an explanation for your observation with the yellow, cyan, and purple color filters arranged in a row in the light path of the light box.

## Task 6

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On a color negative, the objects are depicted in different colors, contrary to our experience. What reason could this have?

## Task 7

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Why is the process of color generation you examined in this experiment called subtractive color mixing?

- ☐ None of the answers are correct.
- ☐ Because by using the color filters the light is extended by one color at a time.
- ☐ Because the color filters block out light of different colors.
- ☐ This term is incorrect and dates back to the early days of research. In the meantime, we know that it should be called "additive color mixing".

☒ Check

## Task 8

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How does the subtractive color mixing process differ from the additive process?

- ☐ By mixing ("adding") spectral colors (electromagnetic waves with a certain spectral range), they are added to a total spectrum. In the simplest case, light of different colors is projected onto one spot, where they add up to a "new color".
- ☐ There are no differences.
- ☐ When producing a so-called subtractive colour mixture, we create different mixed colours by means of various superimposed colour filters (starting from white light, certain colour components from the spectral range of visible light are "subtracted" by the colour filters).
- ☐ By mixing ("adding") spectral colors (electromagnetic waves with a certain spectral range), we create

## Task 9

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Between two subtractive primary colors lies the additive primary color, which results when white light is successively

and falls through filters in the two subtractive primary colors.

☐ True☐ False☒ Check



Slide	Score / Total
Slide 26: Color negative	0/1
Slide 27: Additive vs. subtractive	0/2
Slide 28: Basic colors	0/1

Total  0/4

 Solutions

 Repeat

 Export text