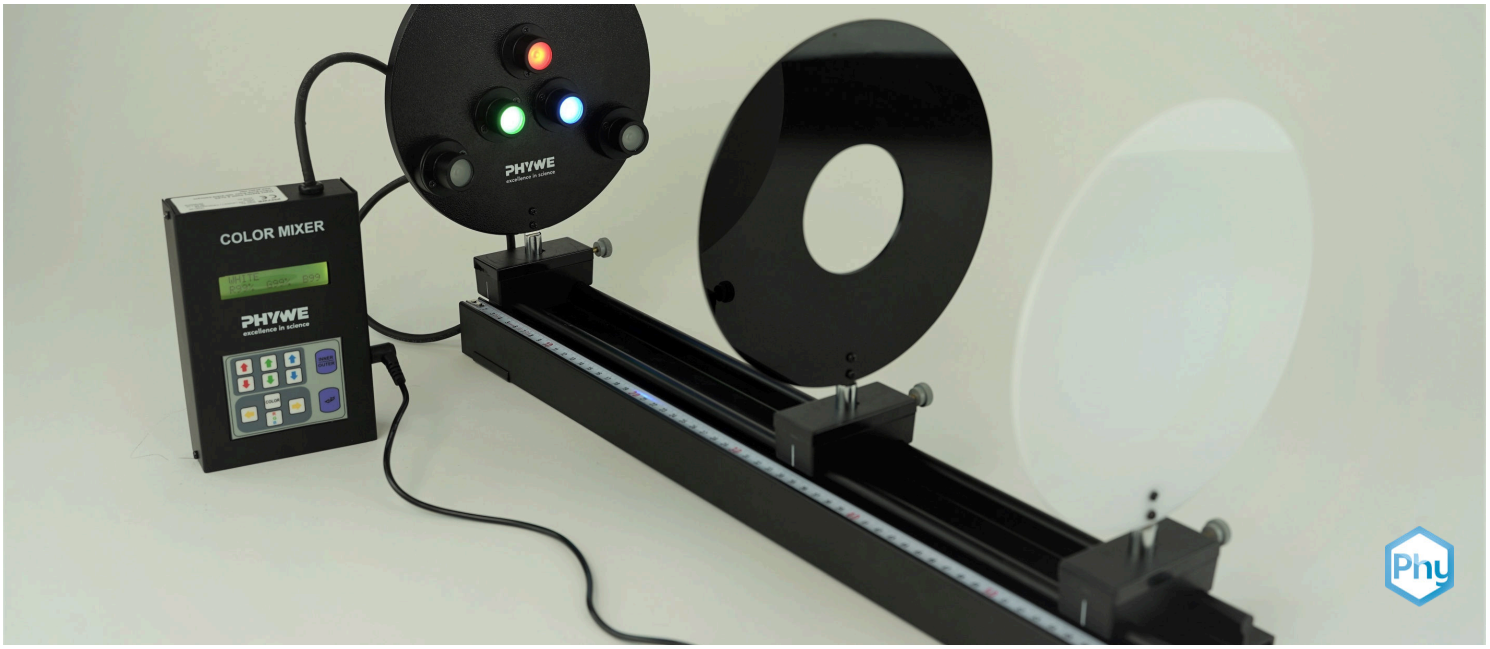
Color mixing in experiments on optical profile bench with LED lamp



Physics > Light & Optics > Optical devices & lenses

Difficulty level	Group size	Preparation time	Execution time
-	-	30 minutes	40 minutes

This content can also be found online at:

http://localhost:1337/c/63e36b360b70ff00030f1434

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General information

Application

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We encounter the principle of additive colour mixing every day. The colours on mobile phone, computer or television screens are formed by mixing the RGB colours. The individual pixels consist of three subpixels in the colours red, green and blue. These subpixels can each change the brightness of their colour. With these three subpixels, all colours can now be represented. To obtain a white image, each subpixel is activated. For a black image, all three subpixels are deactivated.

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Other information (1/2)

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Prior knowledge

Colours are defined as different wavelengths of light between $380nm$ and $750nm$ perceived. The colours of the light are called spectral colours.

Principle

When light rays of different colours meet, their spectral colours are added. This is called additive colour mixing. The mixed spectrum always contains more colour volume than the respective individual colours before it. Usually, three different colours are combined with each other in additive colour mixing.

Other information (2/2)

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Learning objective

The students should learn the principle of additive color mixing.

Tasks

- Investigate the different combinations of LEDs and observe the resulting spectrum.

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Safety instructions

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The LEDs in the product are "ultra bright". Do not look at the LEDs up close when switching on. Do not stare at a bright light source.

Theory (1/3)

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The LED fixture is equipped with a set of LEDs with the primary colours red, green and blue. The fixture consists of six LEDs (three inner LEDs and three outer LEDs). Both the three inner LEDs (red, green and blue) and the three outer LEDs (red, green and blue) are arranged in a circular frame with 120 degree spacing and equal distance to the centre. The radii of curvature for all three outer LEDs are at the same point from the centre of the frame so that the colour mixing is uniform. A control unit is provided to amplify the ultra-bright (red, green and blue) LEDs. The control unit can be operated in indoor or outdoor mode to vary the intensity of the LEDs from 0% to 99%. An LCD screen displays the current setting of each LED. A wide range of colours allows mixing in different ratios. Each LED has a lens that focuses the light into a wide circular beam. A diffuser ensures uniform light distribution. The pinhole included in the scope of delivery creates circles of light that can be displayed on the translucent shade. This effect is clearly visible from both sides.

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Theory (2/3)

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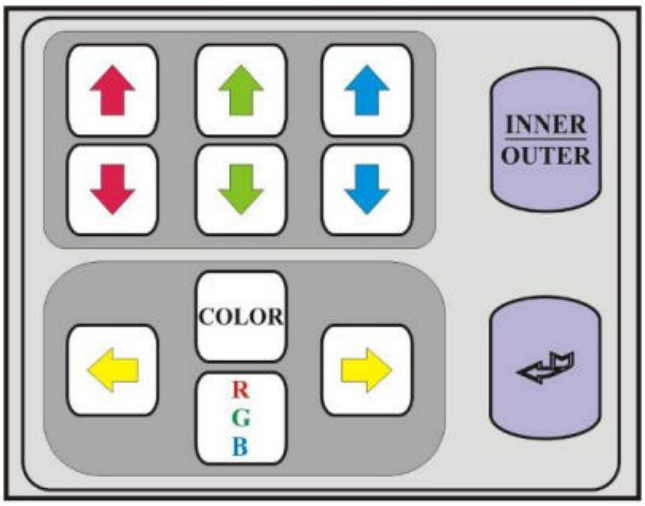
Control unit keypad

- Red, green, blue up key (↑) and down key (↓): With these keys, the intensity of the respective colour can be changed from 0 to 99% in a step of 1%.
- INNER/OUTER key: With this key, the inner or outer LED can be selected.
- Enter key: This key saves or updates the current value of the newly formed colour.



Theory (3/3)

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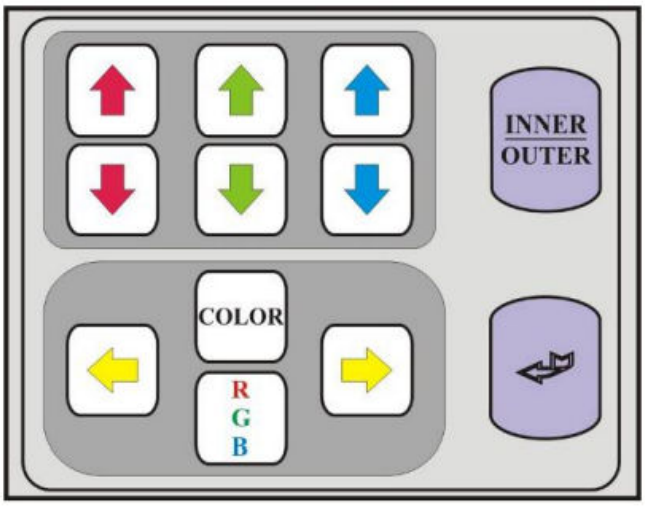
Control unit keypad

- Left button (←): This key is used to display the previous colour and its intensity level.
- Right button (→): This key displays the next colour and its intensity.
- COLOR key: This key is used to select a programme mode.
- R G B key: This key displays the current value or changes the current value of the colours red, blue and green.



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Equipment

Position	Material	Item No.	Quantity
1	LED lamp for colour mixing incl. controller	13761-99	1
2	Optical profile-bench for student experiments, l = 600 mm	08376-00	1
3	Slide mount for optical bench	09822-00	3

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Setup and Procedure

Structure (1/2)

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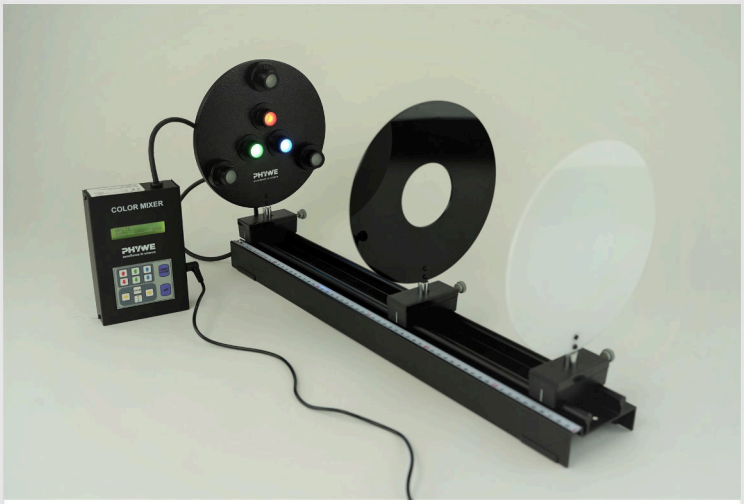

Experimental setup

- Place the optical profile bench on the test table and insert the LED light into the tab at the left end of the bench.
- Attach the screen to the far right end of the bench.
- Now place the cover between the LED luminaire and the shade.

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Structure (2/2)

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- Connect the LED light to the control unit.
- The lamp is operated with the 5V/2A regulated plug-in power supply unit. Only use the light with the power supply unit provided. Connect the supplied 5V power supply unit to the controller and insert the plug into the socket.
- By default, each LED is set to 0% after switching on for safety reasons. The brightness can be increased gradually by pressing the corresponding up key. Alternatively, full brightness can be achieved immediately by pressing the ↓ key once when the display shows 0%.

Control unit of the LED luminaire

Procedure

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- First switch on the green and the red LED and observe the result. Examine how the mixed colour changes when the intensity is varied.
- Repeat the process for the following combinations: Blue + Green, Blue + Red.
- Now switch on all three LEDs and vary the light intensity, what can be observed at maximum intensity of all colours?
- Note down the observations.

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Evaluation (1/2)

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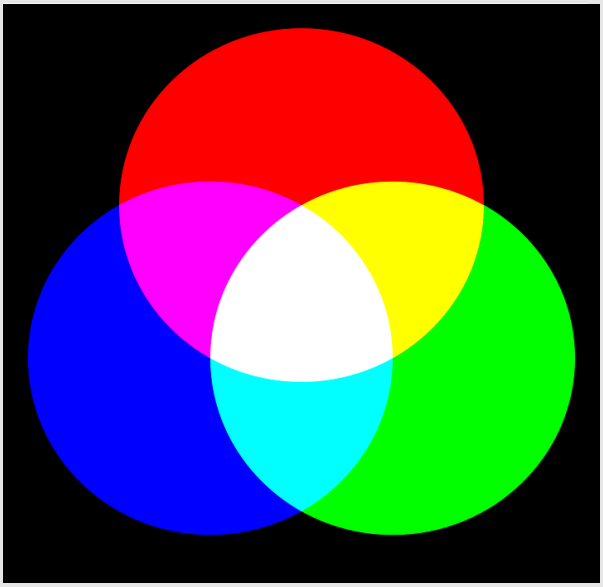

- Depending on the colour and intensity combination, different mixed colours can be observed on the screen.
- An overview of the different mixed colours can be seen in the illustration on the left. Here, the individual spectral colours have an intensity of 100%.

Evaluation (2/2)

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Fill in the blanks based on the observations.

The _____ of additive colour mixing are _____, green and red. The following _____ are created when the three basic colours are mixed additively. The basic colours are assumed to have the same intensity.

Green + red results in _____

Blue + green results in _____

Blue + red results in _____

Green + blue + red results in _____.

magenta

basic colours

yellow

mixed colours

cyan

white

blue

Check

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Slide	Score / Total
Slide 15: Color mixing	0/7

Total score 0 / 7

Show solutions Repeat

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