

Young's Double Slit Experiment

Task and equipment

Information for teachers

Additional Information

In 1801 Thomas Young conducted an experiment in which he shone light from a single light source onto two slits, thus creating two beams of light which, when recombined, displayed the interference phenomenon. The classical investigation delivered final proof of the wave nature of light.

In the first experiment the students will become familiar with the principle of Young's experiment on interference. In a second experiment they will ascertain the wavelength λ of red light.

Suggestions for Set-up and Procedure

Remember that adjustments to the experimental setup must be carried out in a darkened room. It is very important to make sure that the light aperture and the double slit run parallel to each other and through the optical axis. In addition, the light aperture must be adjusted to a suitable width so that both sharply focussed and sufficiently bright interference fringes are created. When carrying out measurements with the measuring magnifier, increase the light in the room sufficiently to read the scale of the measuring device.

Remarks

Observations and measurements will be facilitated if the measuring magnifier is set up at the edge of a table. This makes it easier to look at the light through it.

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Task

How can we use diffraction at a double slit to prove that light interferes?

Direct a narrow beam of light onto a double slit and observe what happens. Determine the distance between the virtual light sources and, using this and the interference pattern, determine the wavelength λ of red light.



Equipment



Position No.	Material	Order No.	Quantity
1	Light box, halogen 12V/20 W	09801-00	1
2	Bottom with stem for light box	09802-10	1
3	Support base, variable	02001-00	1
4	Support rod, stainless steel, l = 600 mm, d = 10 mm	02037-00	2
5	Colour filter set, additive (red, blue, green)	09807-00	1
6	Lens on slide mount, f=+50mm	09820-01	1
7	Diaphragm holder, attachable	11604-09	1
8	Slide mount for optical bench	09822-00	2
9	Screen, white, 150x150mm	09826-00	1
10	Plate mount f.3 objects	09830-00	2
11	Measuring magnifier	09831-00	1
12	Diaphragm, 4 double slits	08523-00	1
13	Slit, adjustable.up to 1 mm	11604-07	1
14	Measuring tape, l = 2 m	09936-00	1
-	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Set-up and procedure

Set-up

- Set up the optic bench with the two support rods and the support base and place the scale in position (Fig. 1 and Fig. 2).



Fig. 1



Fig. 2

- Assemble the light box according to Figures 3 and 4 and clamp it into the left part of the support base with the lens end pointing away from the optic bench (Fig. 5). Insert the light-tight diaphragm in front of the lens (Fig. 6).

Student's Sheet

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Fig. 3



Fig. 4



Fig. 5



Fig. 6

- Place a lens with $f = +50$ mm onto the optic bench directly next to the light box (Fig. 7).



Fig. 7

- Insert the adjustable slit (light aperture) into the diaphragm holder (Fig. 8, Fig. 9) and attach this to the lens (Fig. 10).

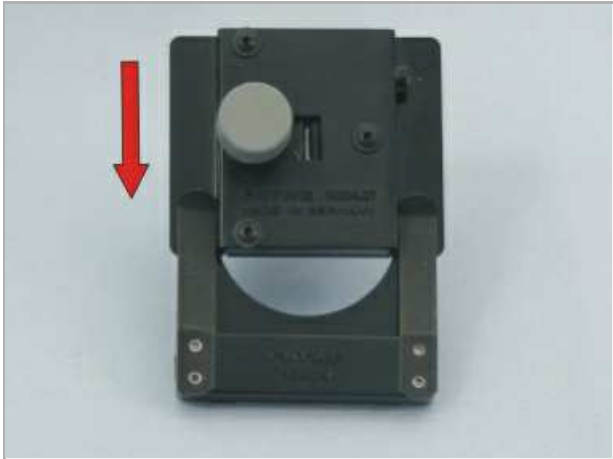


Fig. 8



Fig. 9



Fig. 10

- Set up the plate mount with slide mount at the end of the optic bench (Fig. 11).



Fig. 11

- Attach the diaphragm with 4 double slits to the plate mount so that the double slit with $g = 0.25 \text{ mm}$ and $b = 0.1 \text{ mm}$ is situated in the centre of the plate mount (Fig. 12); cover the other double slits with two light-tight diaphragm (Fig. 13).



Fig. 12



Fig. 13

Procedure

- Connect the light box to the power supply (12 V~) (Fig. 14) and switch on the power supply.



Fig. 14

- Place the screen with slide mount to the right of the optic bench (Fig. 15) and observe fringe patterns on the screen.
- If necessary, slightly turn the light aperture and vary the width of the slit until a fringe pattern gets visible.



Fig. 15

- Remove the screen from mount and replace it by the second plate mount holding the measuring magnifier (Fig. 16).
- If necessary, adjust (width of the slit and parallel alignment of light aperture and double slit) until a bright focussed fringe

pattern appears.



Fig. 16

- Move the plate mount with measuring magnifier further away (0.5 m ... 1 m) from the double slit.
- Observe the interference patterns; when looking into the lens, make sure that your field of vision is evenly illuminated.
- Note your observations under "Result - Observations 1" in the report.
- Insert the red filter into the well of the light box (Fig. 17).
- Using the measuring magnifier, measure the distance d between the red interference fringes. To do this, measure the distance d_n between $(n+1)$ adjacent fringes and calculate the average value. Note your result under "Result - Observations 2" in the report.
- Measure the distance e between the double slit and the measuring magnifier and also enter your result in the report.



Fig. 17

Report: Young's Double Slit Experiment

Result - Observations 1

Describe your observations.

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Result - Observations 2

Enter the values:

$d_n =$ mm

$n =$

$e =$ cm

Evaluation - Question 1

In Fig. 23 one can see the basic setup of the experiment and the ray paths.
On the basis of this figure explain how the interference fringes come about.

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Evaluation - Question 2

Fig. 24 shows us how to derive the equation to calculate the wavelength λ when light is diffracted at a double slit:
 $\lambda = g \times (d_n / (n \times e))$.

On the basis of your results, which wavelength λ do you obtain for red light?

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