PHYS 708

Lab 1

By Jason Phillips

Joe Shields

November 5, 2020

Experiment O601

Total internal reflection inside a prism

Purpose

To understand how a simple camera works.

Equipment

- 1 Optical lamp
- 1 Lens, $f = 100mm$
- Inclined bench and screen
- 1 Tea candle

Procedure

1. Set up experiment like O601 Fig. 1.
2. Light the tea candle.
3. Align screen till the image of the flame can be seen in good focus on it.
4. Observe the image of the candle flame and write a description of it in the table.
5. Determine the object distance g and the image distance b, then enter both values into the table.
6. Now set the object distance to $g = 350mm$ and move the screen until the candle flame is well focused.
7. Determine the object distance b and enter the value into the table.

g in mm	b in mm	Image properties
350		

Evaluation

Additional Exercises

1. A camera is focused by adjusting the highly sensitive distance between the lens and the imaging mechanism/the film.
2. Arrow 1 is in focus.

Complete the following

The brighter the object to be photographed, the shorter the exposure times need to be.

The higher the f-stop value, the smaller the aperture.

Answer the following questions:

Read some books so that you can explain the term depth of field as it relates to the f-stop setting

The depth of field is very shallow for a wider apertures or smaller f-stops, and the depth of the field is deeper for a smaller aperture or higher f-stop.

What does the ISO value represent?

The ISO value is some gauge of the sensitivity of the film to light. The higher the ISO value, the more sensitive it is to light.

Experiment O603

Model Microscope

Purpose

To understand how a microscope works.

Equipment

- 1 Optical lamp

- 1 Optical bench
- 1 Lens, $f = 100mm$
- 1 Lens, $f = 50mm$
- Inclined bench and screen
- 1 Tea candle
- 1 Object (slide)

Procedure

1. Place the optical lamp like in O603 Fig. 1.
2. Connect the lamp to its power supply.
3. Align screen till the image of the slide is well focused on the screen.
4. Cut off a piece of paper with some scissors that fits nicely in front of the light aperture.
5. Make sure to completely cover the aperture with the paper and remove the screen.
6. Place a lens of focal length $f = 100mm$ at the end of the optical bench and look through it at the image of the slide which was previously on the screen (see O603 Fig. 2).

Evaluation

Answer the following questions:

1) What do you observe on the screen?

There is a magnified image of the object which is upside-down and reversed from left to right.

2) What does the image look like when you look at it through the lens?

The image is even more magnified than it was on the screen.

Complete the following:

1) The movable lens is called the objective and the fixed lens is called the ocular.
2) The objective creates an intermediate image which is magnified again by the ocular.

Name some applications of microscopes in medicine, research and production: In medicine, microscopes are used to investigate the causes of illness, in research they are used to investigate the structure of organic matter and in production they are used for checking the quality of products.

Experiment O603

Model Microscope

Purpose

To understand how a microscope works.

Equipment

- 1 Optical bench
- 1 Lens, $f = 100mm$
- 1 Lens, $f = 50mm$

Procedure

1. Place the lenses like in O605 Fig. 1.
2. Look at the object from $10m$ away.
3. Hold optical bench with $f = 50mm$ lens in front of your eye in such a way that you can the object through both lenses.
4. Now determine how far apart the two converging lenses are and compare this with the focal length of the $300mm$ lens.
5. Think about what the relationship between the separation and the focal lengths of the two lenses, and write down your conclusion under relationship.

Evaluation

Conclusion:

Relationship:

Complete the following:

1) The object is a long way beyond twice the focal length of the objective.
2) The image of the object is close to the focal point of the objective.
3) An intermediate image of the object is close to the focal length of the ocular. It is as if it were being viewed through a magnifying glass.
4) The view through an astronomical is of a real image, upside-down, reversed from left to right and reduced in size.

Additional exercises:

1) Explain why astronomical telescopes are not used for terrestrial applications, although the magnification can be very large. The image seen by the viewer is rotated by 180°.
2)Find out a way of correcting the orientation of the image through a Kepler telescope so that it could be used as a terrestrial telescope. One can insert two prisms which both exhibit total internal reflection, but this this also increases the field of vision.

3) Name some applications where Kepler telescopes are used:

For observation of astronomical bodies/events.

g in mm	b in mm	Image properties
350		

Experiment O601

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- Inclined bench and screen
- 1 Tea candle

Procedure

1. Set up experiment like O601 Fig. 1.
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3. Align screen till the image of the flame can be seen in good focus on it.
4. Observe the image of the candle flame and write a description of it in the table.
5. Determine the object distance g and the image distance b, then enter both values into the table.
6. Now set the object distance to $g = 350mm$ and move the screen until the candle flame is well focused.
7. Determine the object distance b and enter the value into the table.

Evaluation

Additional Exercises

1. A camera is focused by adjusting the highly sensitive distance between the lens and the imaging mechanism/the film.

2. Arrow 1 is in focus.

Complete the following

The brighter the object to be photographed, the shorter the exposure times need to be.
The higher the f-stop value, the smaller the aperture.

Answer the following questions:

Read some books so that you can explain the term depth of field as it relates to the f-stop setting

The depth of field is very shallow for a wider apertures or smaller f-stops, and the depth of the field is deeper for a smaller aperture or higher f-stop.

What does the ISO value represent?

The ISO value is some gauge of the sensitivity of the film to light. The higher the ISO value, the more sensitive it is to light.

Experiment O701

Dispersion of light into colors using a prism

Purpose

To investigate how a prism disperses visible light into its separate colors.

Equipment

- 1 Optical lamp
- 1 Optical bench
- 1 Lens, $f = 100mm$
- 1 Slide holder
- 1 Slide with a single slit
- Inclined bench and screen
- 1 Prism
- 1 Rectangular glass block
- 1 Red filter

Sub-Experiment 1

Procedure

1. Follow O701 Fig. 1
2. Place the screen $50cm$ beyond the end of the optical bench.
3. Align screen till the image of the slide is well focused on the screen.
4. Put rectangular glass block about $9cm$ behind the $f = 100mm$ lens, and put the prism on top of it.
5. Place the screen at an angle to the optical bench, maintaining the same distance.
6. Move the screen until the spectrum shows up.

Evaluation

Complete the following:

1) A prism disperses light into a spectrum of colours.
2) The band of all these colours is called a spectrum. Colours in a spectrum cannot be dispersed any further.
3) Because the spectrum is formed by a prism, it is sometimes called a prismatic spectrum.
4) The colour red is least diverted from the straight path and the colour violet is refracted the most.
5) The correct order of the colours is red, orange, yellow, green, blue and violet.

Sub-Experiment 2

Procedure

1. Now slot the red filter into the slide holder and position it directly in front of the optical lamp (see Fig. 3).

2. Observe the spectrum on the screen and write down what you see.

Evaluation

The spectrum as seen now only contains red light. The red light is not comprised of any substituent colors.

Additional exercises:

A rainbow is created by refraction and reflection of sunlight by water droplets when the sun is shining through them from behind the observer. The reason for the emergence of the colours is dispersion by the droplets, which act similarly to a prism and refract the components of white light to differing degrees.

Experiment O703

Addition of colors- Complementary colors

Purpose

To investigate the possibilities for the addition of colors.

Equipment

- 1 Optical lamp
- 1 Optical bench
- 1 Lens, $f = 100mm$
- 1 Slide holder
- 1 Slide with a single slit
- Inclined bench and screen
- 1 Prism
- 1 Semi-circular body
- 1 Parallel block
- 1 Plastic jar with lid
- 1 strip of paper $20 \times 20mm$
- 1 strip of paper $20 \times 300mm$
- 1 Rod, $2mm$
- Adhesive tape
- Water

Setup

1. Follow O703 Fig. 1
2. Place screen $60cm$ away from the optical bench at an angle which accentuates the spectrum.
3. File the plastic far with water and close the lid.

Blocked-out spectral color	Complementary color
Red	
Orange	
Yellow	
Green	
Blue	
Violet	

4. Use the semi-circular body to place under the jar of water and place the jar in the beam between the prism and the screen, so that it is about $5cm$ in front of the screen.

5. If necessary, move the plastic jar and the semi-circular body so that that the white slit can be seen on the screen next to the spectrum.

6. Attach a paper strip to the plastic jar in such a way that the spectrum is visible on the strip and the white slit is visible on the screen.

Procedure

1. Use the rod to block off the red light in the spectrum, observe the white strip on the screen and enter the color that results into the table.

2. do the same with the other spectral colors and enter into the table the color that can be seen on the screen in each case.

3. Now block off multiple colors with the paper strip and observe the resulting color on the screen.

Answer the following:

1) Is it possible to find out what happens when the blocked-off colours and the complementary colours are added? Yes, by removing the rod or paper strip again.
2) What colour results when the colours are mixed? The mixed colour is white.

Complete the following:

1) When colors are added together a mixed color results where the spectral colors overlap.
2) In the case of subtractive color mixing, the mixed color is the result of absorption of certain colors from white light.
3) The colors that are obtained by mixing paints arise due to subtractive mixing of colors.