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Experiment Name and No.: Light patterns & Shadows, EXPT-1

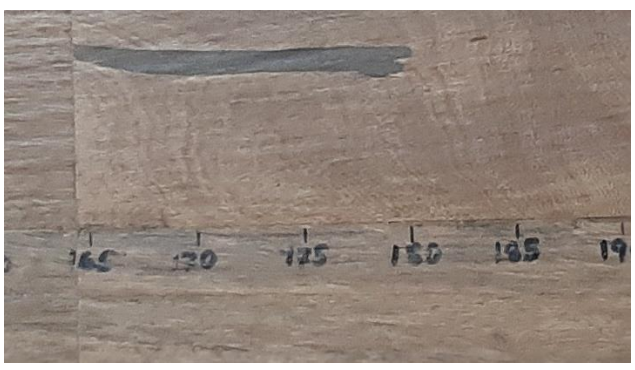
Part A:

Aim:

To find out the properties of the image formed by light passing through a circular aperture.

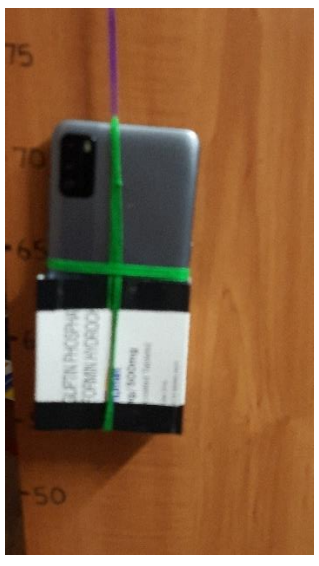
Setting up the experiment:

To make the measurement of distances easier, I used a marker to mark distances at an interval for 5cm each for a total length of 4m.

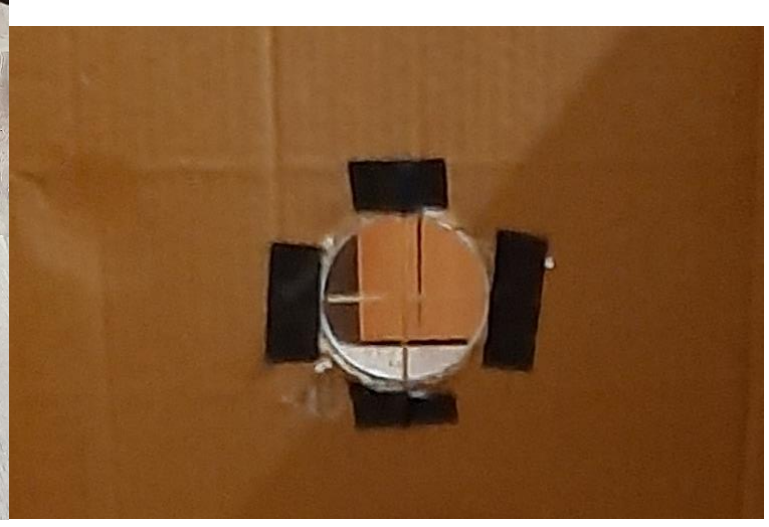


For the measurement of heights, I did a similar things on the side of my old study-table to mark a total length of 1m with markings at intervals of 5cm each.

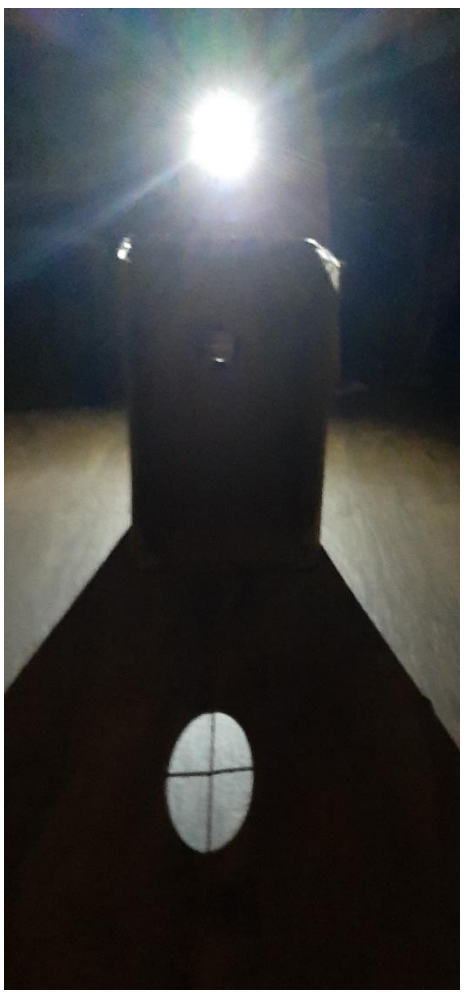
As a light source, I used my mobile. To keep the mobile steady and to help in the proper measurement of the height of the light source, a pulley like system was made to hold the phone in place.



For the circular aperture, I cut out a circle of radius = 5.5cm fom an old cardboard box. Also, I attached two small sticks of wood(taken from the dried midrib of coconut leaves found all over Kerala). The sticks were added to help for the propar measurement of the axes of image formed, its position and whether its centre corresponded with the centre of the circle.



This was the result after setting up all the parts:



These are some videos of the experimental set-up: Video1 and Video2

1st Case:

Finding d(distance between aperture and image):

The thickness of the cardboard is $4 \times 10^{-3}\ m$. This had to be subtracted to correct the value found be measuring using the tape.

The circular aperture was fixed at a distance of 1m.

The table I got from the experiment is attached here: Table1

Please Note: In the graph the physical quantities have been marked using centimetre.

From the table, I was able to plot the following graph: Graph1

2nd Case:

Finding L(distance between light source and aperture):

The thickness of the cardboard is $4 \times 10^{-3}\ m$. This had to be added. The thickness of the mobile $8 \times 10^{-3} m$ had to removed to correct the values in measurement obtained via measurement tape. Therefore a net of $4 \times 10^{-3}\ m$ had to be subtracted.

Finding d:

The same correction as in case 1 had to be made. The light source was fixed at a heigh of 0.7 m height

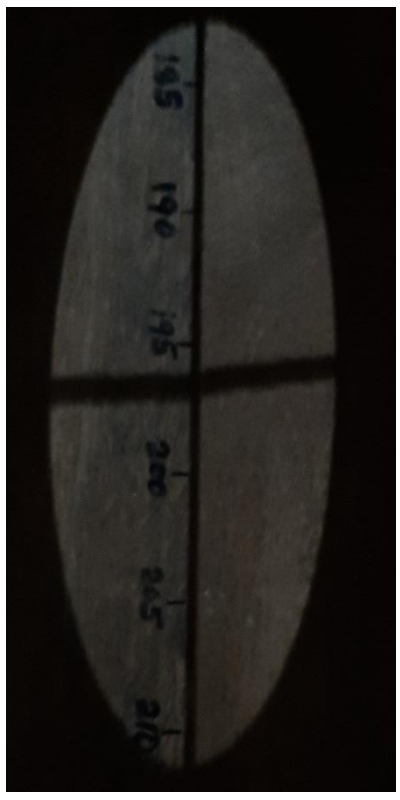
The table I got from the experiment is attached here: Table 2

Please Note: In the graph the physical quantities have been marked using centimetre.

From the table, I was able to plot the following graph: Graph2

QUESTIONS:

1. The centre of the ellipse corresponded with the centre of the circular hole. As mentioned earlier, I had attached two small pieces of wood along the diameters of the circular hole such that they approximately passed through the centre of the circle. When the image of the ellipse was formed, the centre of the ellipse was also at the intersection of the images of the two sticks. So, the centre of the ellipse does correspond with the centre of the circular hole.



2. The patterns on the ground were real ellipses. This I found out because, from the value I found, the major axis and the minor axis bisected each other every time and therefore, I concluded that all the images formed were real ellipses.

Part B:

Aim:

To study the phenomenon of formation of two shadows by a thin obstacle on a mirror.

Setting up the experiment:

All the other props from Part-A were used except the carboard holding the circular aperture which was replaced by a 5mm = 0.005m thick glass mirror which I found in my house and a thin line was marked using a marker. A whiteboard was used as the screen and fluorescent measuring tape which was luckily available in house was used to measure the height of the image formed.

This was the double image formed:

Video of set-up: Video3

Sub-Part 1

Calculation of h(height of light source) and H(height of image):

Thickness of mirror is $5 \times 10^{-3} m$. So it had to be subtracted from the measured height from ground.

I made 5 sets of D and h and got the following table: Table3

Sub-Part 2

Distance between screen and obstacle is fixed at 0.80m. Distance between light source and obstacle was fixed at 1.50m. The same correction in h and H were to be made as in Case -1.

I got the following table of values: Table4

Please Note: In the graph the physical quantities have been marked using centimetre.

And I plotted the graph: Graph3

Another thing I observed was that the plot of H vs h was a straight line, which means that it the relation is of the form H = kh where k is the slope. This k was found to be approximately = 1.60.

To find the height of bulb in the room:

Using the observations from case2, Distance between screen and obstacle is fixed at 0.80m. Distance between light source and obstacle was fixed at 1.50m.

Height of the image formed(H) was found to be 1.585m. After correction the Height of image formed was 1.58m.

I extrapolated the graph I got from the measurements in case2, I drew a horizontal parallel to the X axis to find out the point where y= 1.58m intersected the graph. Using this, I found out the corresponding value of height of light source(h) by making a perpendicular drop parallel to Y axis. It was observed as 251cm = 2.51cm. That was the height of the light source.

Then I measured the actual height of the bulb using a ladder and measuring tape and the height was measured as 255 cm – 2.55cm. The error was only 4cm.

Other observations:

1. I found out that as the height from the mirror increased, the size of the image became more like the mirror and distance between the two images(of the obstacle formed) gradually became equal to the thickness of the mirror.
2. I also found out that this phenomenon not only worked with a small marked line but with all kinds of objects which had any length and height. I noticed that the only thing required for this phenomenon was small width. I was able to see even two images of my fingertips and two images of ruler when I placed them in such a way that their narrower side came into contact with the mirror.

Acknowledgement

I would like to thank my younger sister and my parents who helped me in filming and in organising the experiment. I would like to thank NAEST for giving me the opportunity to do the experiment. I would also like to thank the NAEST for giving me some extra time to submit as I had my NTSE exams on the 24th of October.