NAEST 2022 Prelims EXPT-3

There are three parts of the experiment, Part-A gives you a problem based on reflection of light and Part-B and C on refraction through a thick cylindrical lens. In part C the focus in on the dispersion of light by the lens into different colours.

Part-A: Finding the height of the bulb

A small tiny mirror (such as that studded in fancy dresses) will be used here to study the reflection. Choose a room with a bulb on a wall. Place the mirror on the floor at a certain distance from the wall so that the triangle formed by the bulb A, the foot of perpendicular from the bulb to the floor B, and the mirror C are in a vertical plane perpendicular to the wall (see figure1). Stand in the room at such a position D that you can see the image of the bulb in the mirror. Let the eye be at the position E.

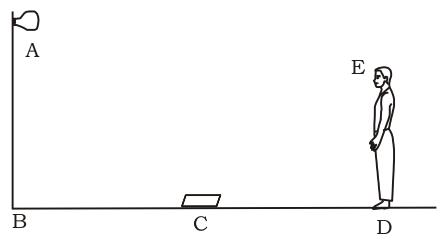

figure 1

Measure the distance x = BC, and y = CD. Place the mirror at different positions on the line BC and repeat the experiment. Plot y versus x. Find the slope of the line you get.

What physical quantity does this slope represent?

Find the height of the bulb from the floor using your data and your own height. Verify your result by directly measuring the height of the bulb.

Questions: Describe the possible sources of error and the steps you have taken to reduce them.

Part- B: Study the Magnification by a cylindrical water lens

For a thin convex lens, real image can be obtained on a screen by placing an object at appropriate distance from the lens. If the object is perpendicular to the principal axis, the image size/object size is called the magnification. This magnification is equal to v/u where v and u are the distances of the image and the object from the centre of the lens.

In this experiment you will study the magnification relation for water in a cylindrical container as a lens.

Set-up:

Take a good transparent cylindrical glass container. It can be a beaker, a tumbler or any other container with good transparency. A diameter of about 8 cm gives good results. Paste black papers on the container to allow only the middle portion of few centimeters height to be exposed. Place it on the working table/floor and put a white screen in front of it. Fill the container with water. Your lens is ready (figure2).

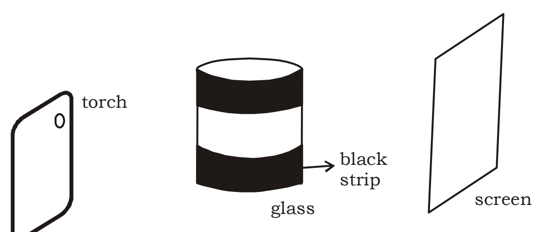

figure 2

Use your mobile phone torch as the source of light and also the object. Arrange to fix it properly so that the torch height is somewhere in the middle region of the exposed part of the container.

Experiment

After you fill water in the container, adjust the position of the mobile torch, container and screen so that the light rays after passing through the water are collected and focused on the white screen. Measure the distance u of the torch and v of the screen from the center of the container. Describe how you measure these distances.

In this position, put a pencil AB or any other object of few centimeter length on the floor near your mobile torch. Its length should be perpendicular to the line from the torch to the screen. This pencil will be your object but you will not find the image of the pencil on the screen. But you can still get the image positions for the ends *A* and *B* of the pencil.

Set the position of the mobile torch in such a way that it is exactly above the end *A* of the pencil. Look at the image of the torch on the screen. Mark the position A' of the image. Now, set the position of the mobile torch in such a way that it is exactly above the end *B* of the pencil. Look at the image of the torch on the screen. Mark the position B' of the image. $A'B'$ will be the size of the image of the pencil.

Magnification = $A'B'/AB$

Repeat the process by changing the distance of the torch from the container. Tabulate your data and plot a graph between the magnification $A'B'/AB$ and v/u.

Part- C: Focal length for blue and red light

Set-up:

In this part we will disperse the light in different colours using the water lens. To get the best results, only the marginal rays should be used. Thus block the central part of the exposed portion by pasting another black strip (figure 3).

Set the mobile torch at a place in front of this central black strip. Light will go through the sides of the strip. You are likely to see a shadow of the black strip on the screen.

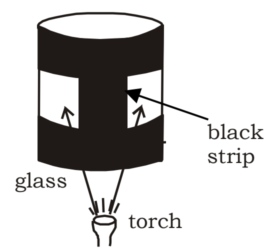

figure 3

Question: Describe the appearance of the shadow. If you see colours, name them.

Slowly adjust the distances so that the shadow becomes thinner and finally vanishes. Just before this you will see a red thin line in the central region of the illuminated part on the screen. When the red line is best focused, measure the distance u of the torch and v of the screen from the centre of the container. Use $1/v + 1/u = 1/f$ to get the effective focal length of the water lens for the red light. Similarly, find the effective focal length for the blue light.

Repeat the above procedure for several values of the distance between the container and the torch.

Extra exploration: You can find ways to extend the experiment. Some suggestions are:

i) For part A, you can vary the size of the mirror/take an extended source of light and study their effects

ii) For part B and C, you can vary the size of the beaker and study its effect on the results.

Expectations:

1. A clear photo each of the set-up of the container (with its black strips), torch bulb and the screen in part-B and part-C
2. Less than 1-minute videos to show
   i) The image of the bulb in the mirror in part-A
   ii) The image of the torch for the two positions A and B of the pencil in part-B
   iii) the set up when red line or blue line is focused on the screen in part-C
3. Neatly tabulated observations, graphs and calculations.
4. Error analysis of the data and the results obtained
5. A report describing your entire experiment, observations, graphs and inferences in a pdf format.