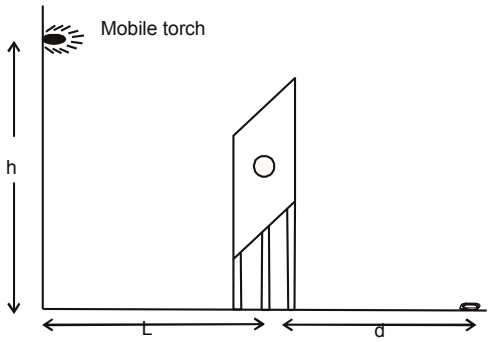
NAEST-2021

Prelim experiment 1: Shadow formation

When light goes through apertures or falls on obstacles, it forms beautiful patterns on the screen. The study of these patterns leads to very interesting results which can be used to find important parameters.

Part-A: In the given setup, light from a mobile torch falls on a circular aperture made in a cardboard/plastic and forms ellipse-like patterns on the floor.

Experiment arrangement: Make an arrangement such that you vary the height *h* of mobile torch from the ground in a range of about few centimeters to a meter. Take a cardboard or a thin plastic sheet and cut a neat circular hole of around 5cm-10cm diameter. Make it stand vertically such that the light from the torch goes through the hole and forms an ellipse-like pattern on the ground. 'd' is the distance from the centre of the ellipse to the cardboard.



Ist case: Keeping the position of cardboard fixed, vary the height *h* of the mobile torch and note the variation in *d*. Plot d vs *h* .

Measure the 'major axis' a and 'minor axis' b of the ellipse-like patterns. Plot a/b vs *h*.

IInd case: Keeping the position of the mobile torch fixed at a certain height, vary the distance *L* and note the variation in *d*. Plot *d* vs *L*.

Measure the 'major axis' a and 'minor axis' b of the ellipse-like patterns. Plot a/b vs *L*

Questions to explore

1. Does the centre of the ellipse correspond to the centre of the circular hole?
2. Are the patterns formed on the ground real ellipses?

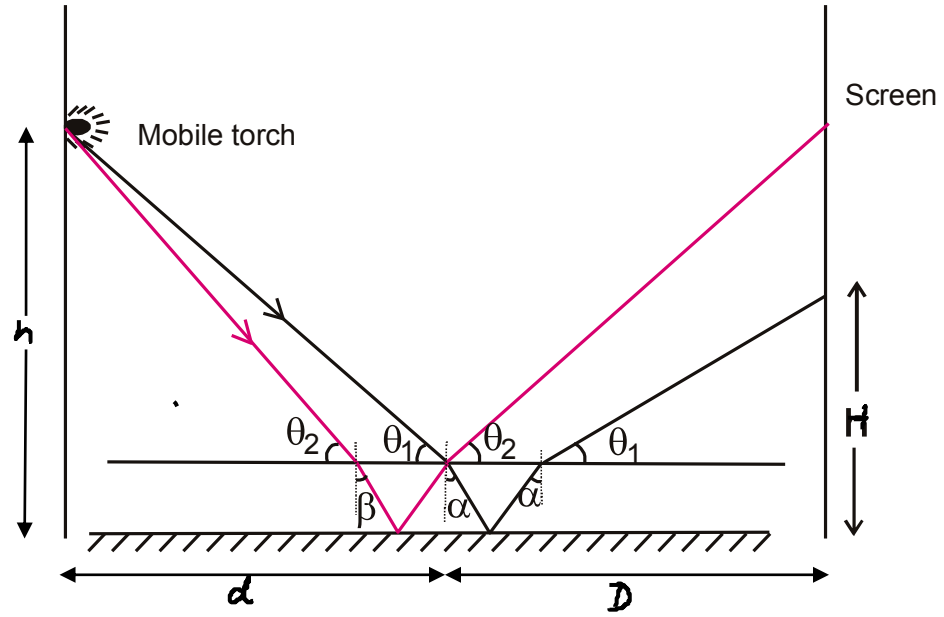
Justify your answers with your experimental data.

Part B: Study the shadow of a thin obstacle placed on a mirror.

Take a small plane mirror. Make a thin line on it with a marker or stick a hair strand on it: this acts as an obstacle. Place the mirror on the floor and collect the reflected light on a wall or a screen. You will see two shadows of the obstacle. Let D be the distance between the obstacle and the screen and h be the height of the torch above the ground

Measure the height of the two shadows from the ground for four to five sets of D and h. Also find the separation between the two shadows in each case.

The path of light as it falls on the mirror and its obstruction due to the obstacle is shown below.



Now fix the position of the mirror and screen from the mobile torch. Plot a graph of H vs h. With the help of this graph, find the height of the bulb in your room from the ground. Explain the steps in detail.

Suggested extra exploration:

- From your data, explore how you can find the refractive index μ of the glass used in the mirror. Give details.
  Note that,
  $$\mu = \frac{\cos\theta_2}{\sin\beta} = \frac{\cos\theta_1}{\sin\alpha}$$
- Other investigations you can think of