Determination of the focal point of different mirrors using LASERs

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Abstract

We are used to see mirrors everywhere all the time, different kinds of mirrors, without knowing how they work.

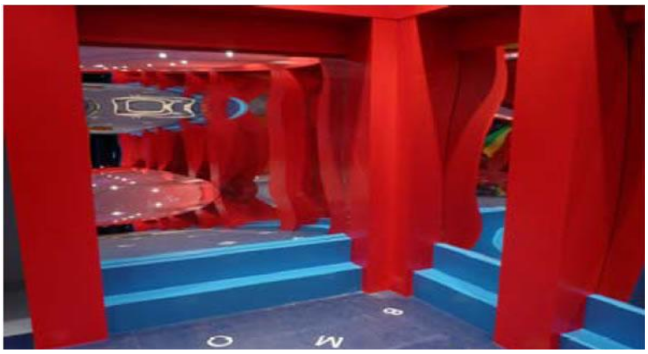


Image 1Mirrors' room, that is called Miramiralls, where we made the experiments.

A mirror is an object that reflects light and it forms an image equal to the real one. The first mirrors used by people were most likely pools of dark, still water, or water collected in a primitive vessel of some sort. The earliest manufactured mirrors were pieces of polished stone such as obsidian, a naturally occurring volcanic glass. Nowadays, mirrors are often produced by the wet deposition of silver (or sometimes aluminium) directly onto the glass substrate. With the help of a LASER we are going to find the focal points of different mirrors at the Miramiralls, an Tibidabo's Park attraction in Barcelona. Using some LASERs and microscopic sliders we will dive into the darkness to achieve our objective.

Introduction

First of all we will introduce what the focal point is and how we will use a LASER to help us finding it. After that we will describe the experiment, in this point we will talk about the material we used and how we used it. Then we will expose the results obtained and what do they lead to, we also will comment the possible errors, we also will make a conclusion. Finally we will see different possible applications of the focal point.

Theory

A LASER (light amplification by stimulated emission of radiation) is a device that generates a beam of coherent light of a suitable medium and with the size and shape in control. The difference between LASERs and other lights is the coherence. Spatial coherence is typically expressed through the output being a narrow beam which is diffraction-limited.

The focal point or image point of a mirror is where the beams of light meet after reflecting from a concave or convex mirror.

A convex mirror, fish eye mirror or diverging mirror is a curved mirror in which the reflective surface reflects toward the light source. Convex mirrors reflect light outwards; therefore they are not used to focus light. The focal point is an imaginary point "inside" the mirror, which cannot be reached, so these types of mirrors always create virtual images. As a result, images formed by these mirrors cannot be projected on a screen; the image is inside the mirror.

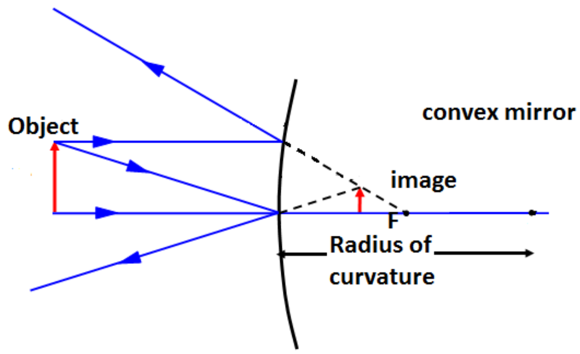


Image 2 Graphical representation of a convex mirror.

To know where the focal is we will do as if we were in a coordinate axis. The points from which the light is broadcasted and the ones which are reflected in the screen will have different coordinates *x* and *y*. The first ones will give us the height from the ones we have to use, the ones from the mirror, so then we just have to know the *x* of these points. Using them we can calculate the straight line that has two of them included. If we do the same with the other two points we just have to know in where the lines coincide. This will be the focal point.

A concave mirror is a curved mirror in which the reflective surface reflects inwards. They also show different image types depending on the distance between the object and the mirror. If the object is between the focal point and the mirror surface, the image will be virtual. On the other hand, if the object is at the focal point, the image will not exist and if it is behind the focal point, the image will be real. In this last case, the real image could be inverted, depending on the distance between the object and the mirror.

Experiment description

Before the day of the experiment we had to prepare all the material we were going to need. First of all we used a saw, a rule, a set-square, a pencil and a rubber to make six different cuts in a wood plank, so we were going to be able to introduce six microscopic slides in them. The cuts had an inclination of 45º respect the horizontal. Then, we put a plastic tube in front of each microscopic slide so the beam of the LASER, which is a line, will turn into a plane while crossing it. We called this apparatus “Reflexeitor”. We used laboratory pincers to hold the “Reflexeitor” to the long iron bar. The last thing to do was to hold a LASER under the last microscopic slide using an iron bar and also a laboratory pincer.

The day of the experiment we used two different mirrors to find or to help us find the focal point, one for each, the concave and the convex mirror.

For measuring the focal point of the convex mirror the first thing to do is to put the “Reflexeitor” (and its support) in front of the mirror and the screen behind it so it is possible to see the different lines from the beams projected on the screen. After that we take the measures shown in “preliminary results”.

For measuring the focal point of the concave mirror we also have to put the “Reflexeitor” (and its support) in front of the mirror, after that we put the LASER on. Immediately the beam of the LASER crosses the microscopic slides and while going through each of them it splits in two beams. One of them is reflected towards the mirror and the other one continues its way to the next microscopic slide. The next thing to do is to put a screen behind the “Reflexeitor”. In the screen it is possible to see where the beam it is reflected from the mirror. As there are different beams there are different lines projected on the screen. If we move the screen frontwards or backwards the beams or approach between them or take distance from the others. So if we move the screen until all the lines coincide we will have found the focal point. After we find it, we measure the distances as shown in the pictures at “preliminary results”- where we are going to expose the results obtained.

Preliminary Results

The following pictures show the data collected during the experiment:

- Convex mirror:

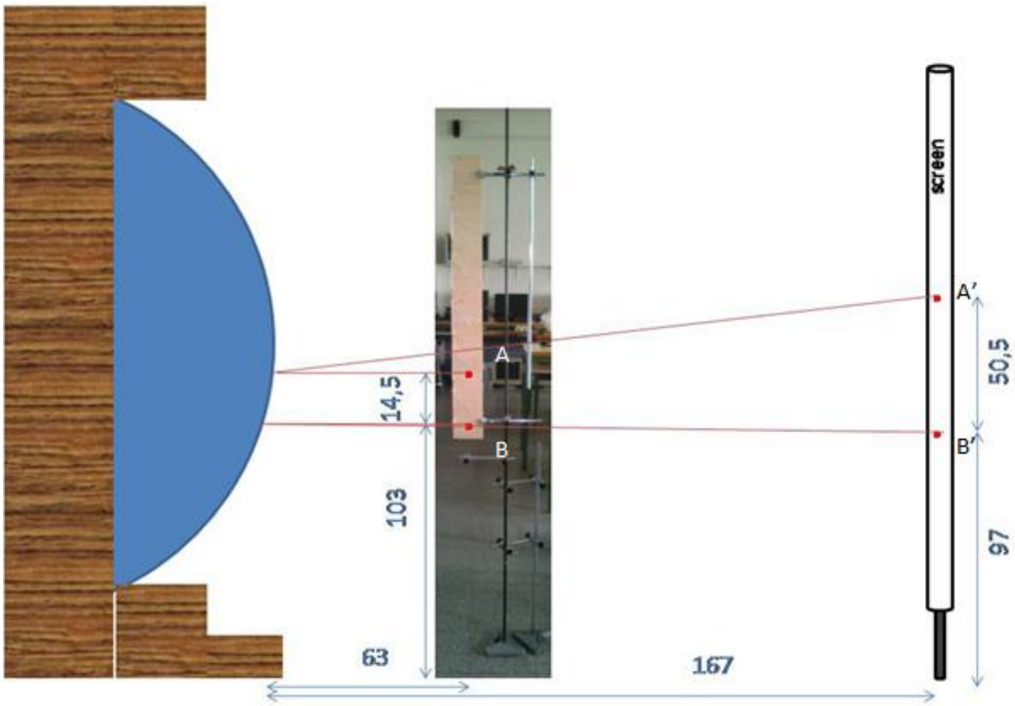
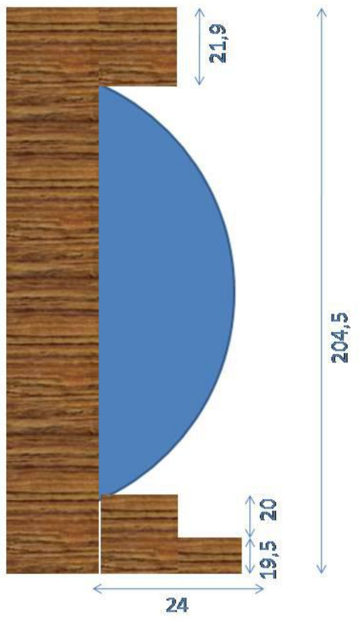


Image 3 Representation of the “Reflexeitor”, the convex mirror and the screen with their measures.



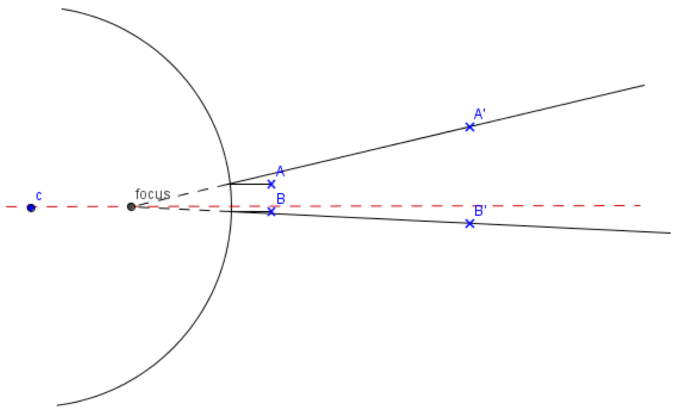


Image 4 Measures and beam's direction.

A and B are the points from where the LASER beam is emitted and A' and B' are the points where the LASER is seen in the screen.
All the measures are taken in cm. Knowing the distances shown we can calculate were the focal point will be using the calculus explained in the theory as shown in the picture. Finally, we find that the focus is 53 cm from its reflective surface.

- Concave mirror

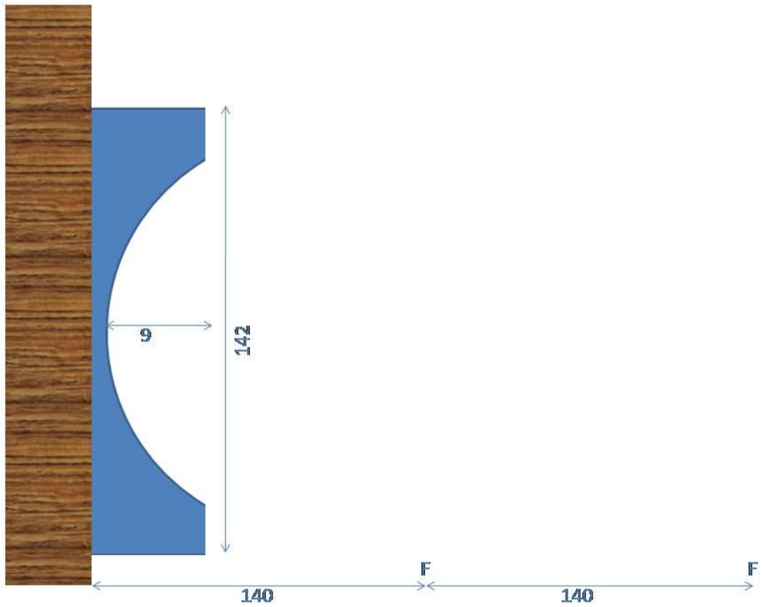


Image 5 Representation of the concave mirror with its measures.

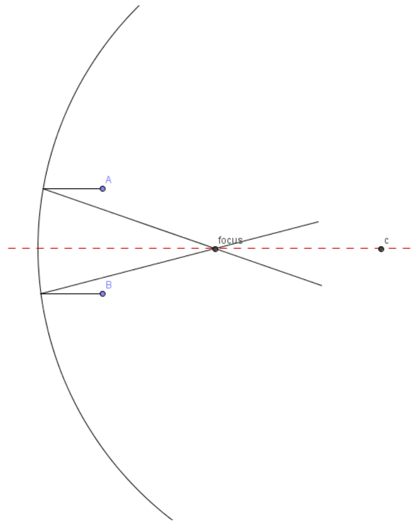


Image 6 Representation of the beam's direction.

In this case A and B are two of the LASERs. To find the focal point we just have to measure the length between the points at the screen were all the beans coincide and the reflective surface of the mirror. So we found that the focal point of the mirror is located at 140 cm from its reflected surface.

Conclusion

We have not had enough time to do all what we wanted because another goal to reach was to calculate the focal point of some of these mirrors which are both, convex and concave, at the same time.

Knowing where the focal point is located and at which distance an object is from it, it is possible to recreate the object's image. That's why at the end we decided to take pictures in front of the mirrors so it will be possible to study them.

This experiment has let us to see up close the optical world, in particular, their operating. It has been really productive and amazing. We have been able to combine the fascinating world of physics with the entertainment of a theme park, a place where you thought you could just have fun going in the roller coasters. We have been improving our physical knowledge studying and having fun at the same time!