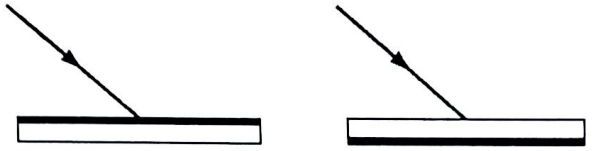
## Exercise 1**----------

The figure below shows two types of mirrors. For one of the mirrors, the incident rays are sent directly to the reflecting face; this is the case for mirrors used in optical instruments or lasers. For the other mirror, the rays pass through a thin glass plate before arriving on the reflective metal deposit; this is the case for household mirrors or rear-view mirrors.

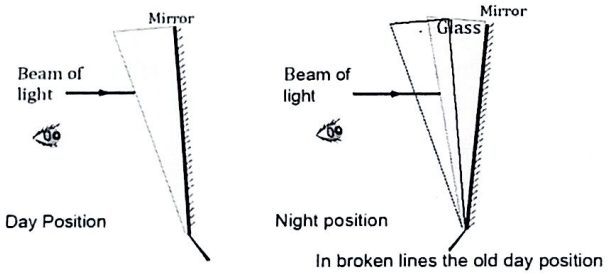
1. Discuss the stigmatism of these two mirrors.




## Exercise 2**----------

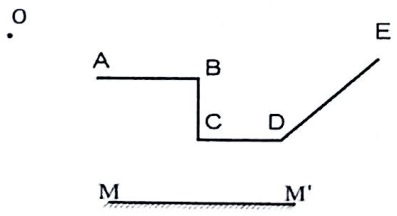
A rearview mirror in a car is used in two different positions. A daytime position where the driver observes an image formed by the rays reflected by the metallized face of the mirror (left figure, below) and a nighttime position where the observed image is formed by the rays reflected by the air diopter -glass (right figure, below). This last position helps reduce the glare from car lights behind.

1. Explain the effect of the two positions by completing the path followed by the incident ray.




## Exercise 3 **----------

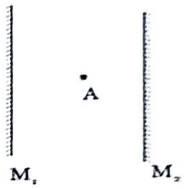
1. Construct the image of object ABCDE given by mirror MM'.
2. Determine the portion of object ABCDE that can be seen by the eye of an observer at point O as shown in the figure below.




## Exercise 4**----------

An object is located between two parallel mirrors **M1** and **M2**.

1. How many images of the object do the two mirrors produce? Draw the four closest images of the mirrors.
2. How can we check the parallelism of the two mirrors?



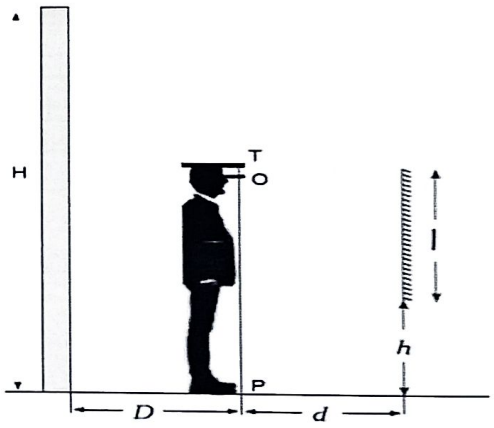

## Exercise 5 **----------

On horizontal ground, **15 m** from the base of a tree, there is a small puddle of water. Anobserver, whose eyes are **1,5 m** from the ground, must stand **2 m** from this puddle of water to see the top of the tree by reflection.

1. Determine the height of the tree.

## Exercise 6**----------

A man, of height **TP**, is standing in front of a vertical plane mirror of length **l**. In the figure below, **T** is the top of the man's head, **O** his eyes, and P his feet.




1. What must be the minimum value of the mirror's length **l** and its height h for this man to be able to see himself completely?

**N. A. :** The man's height TP is **1,80 m** and his eyes are **0,12 m** from the top T of his head. 1.

2. The man is standing at a distance **d** from the mirror and at a distance **D** from a wall of height **H**, located behind him. What must the values of l and h be for the man to be able to see the wall, at its full height, through the mirror?

**N. A : D = 4 m, H = 2,60 m, d = 1 m.**

## Exercise 7**----------

An observer **O** is placed **2 m** from a vertical plane mirror.

1. How far is he from his image **O'**?
2. He moves **50 cm** away. How much does his image move relative to **O'**, and in what direction?
3. He returns to his initial position, and then the mirror is moved **50 cm** away. How much does his image move relative to **O'** and what direction?

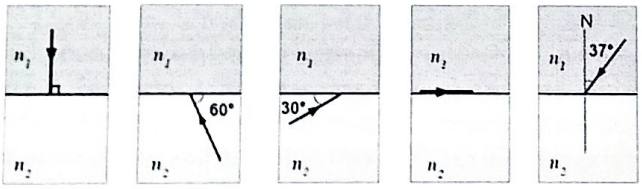
## Exercise 8 ----------

A light ray strikes a plane mirror at an angle of incidence of **50°**.

1. What is the deflection of the light ray?
2. The mirror is rotated **20°** in the plane containing the incident ray and the mirror's trace. By what angle has the reflected ray rotated, and in which direction? What is the new deflection of the incident light ray?
3. A small plane mirror is exposed to the sun. The reflected light strikes a wall **6 m** from the mirror at right angles. The mirror is rotated **2°**. How much does the light spot on the wall move?

## Exercise 9**----------

Construct, in each of the above cases, the reflected and refracted rays. Specify, for each case, the values of the angles of incidence $i$, refraction $r$, and reflection $i'$. Given: $\frac{n_1}{n_2} = \frac{1}{2}$.

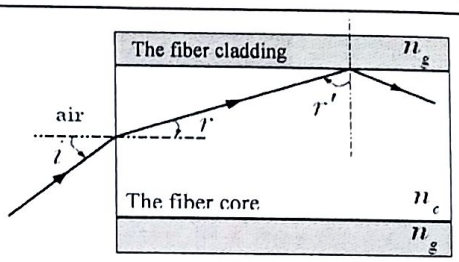



(a) (b) (c) (d) (e)

## Exercise 10**----------

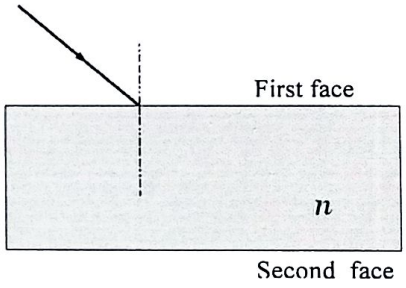
An optical fiber is a glass or plastic cable (the fiber core) with a refractive index $n_c$, surrounded by a material (the fiber cladding) with a refractive index $n_g$, where $n_g < n_c$. Using the phenomenon of total internal reflection, the optical fiber is able to transmit laser light along its entire length without any energy loss. In the figure below, a laser beam is shown entering by one end of the fiber at an angle of incidence **i**.

Given that $n_g = 1.48$ and $n_c = 1.52$, for which values of **i** does total internal reflection occur at the core-cladding interface?




## Exercise 11**----------

A parallel-sided plate is a transparent and homogeneous medium, bounded by two flat and parallel surfaces, which act as plane interfaces. A laser beam traveling through air strikes the first surface of the plate (see the figure below) at an angle of incidence **i**. Let **n** be the refractive index of the plate.




1. Taking into account one reflection and one refraction at each type of interface, draw the path followed by the incident ray. Depending on the direction of propagation of the laser beam, each surface defines either an air-to-plate or plate-to-air interface.
2. Show that the ray emerging from the other side is parallel to the incident ray.
3. Discuss the case of a grazing incidence.

## Exercise 12**----------

A fish's eye is located **60 cm** from the free surface of the water. Above it is a fisherman whose eye is **90 cm** from the water surface (**n=4/3**)

1. At what distance from the water surface does the fisherman see the fish's eye **A**?
2. At what distance from the water surface does the fish see the fisherman's eye B?
3. In each case, trace the path of a light beam that allows the other fish's eye to be seen.

## Exercise 13----------

A tank, whose horizontal bottom is a mirror plane, contains water to a depth of **12 cm**. **9 cm** above the free surface, there is a point light source **S**.

1. Draw, specifying their nature, the successive images of S given by the optical system described above.
2. Calculate their positions.