

Exercise 1**-----

A thin biconvex lens, with radii of curvature $R_1 = R_2 = 2 \text{ cm}$, has a refractive index $n = 1.5$ and a focal length $f = OF$. The lens is placed in air with a refractive index $n' \approx 1$.

- 1- Recall the relationship giving the focal length as a function of the refractive index n and n' and the radii R_1 and R_2 . Calculate OF .
- 2- Deduce its optical power C in m^{-1} . Is it a converging or diverging lens? Represent the lens by specifying the foci F, F' on the optical axis of the lens.

Exercise 2-----

A beam of parallel rays, propagating in air, is sent onto a plan-convex lens in a direction parallel to the optical axis of the lens. Knowing that the refractive index of the lens is equal to **1.5** and that the radius of curvature of the spherical face is **4 cm**, determine the position of the point where the incident rays will focus.

Exercise 3**-----

We consider a thin biconcave lens, with radii of curvature $R_1 = 10 \text{ cm}$ and $R_2 = 20 \text{ cm}$. If the lens is made of flint (potassium silicate), with a refractive index $n_1 = 1.66$,

1. What will be its nature and focal length when:
 - It is immersed in air ($n_a \approx 1$).
 - It immersed in water ($n_w = 1,33$).
2. If the lens is made of flint (CaF_2), with a refractive index $n_2 = 1.43$; what will be its nature and focal length when it is immersed in carbon disulfide (CS_2) of refractive index $n_3 = 1.63$.
3. What can be concluded after analyzing the obtained results?

Exercise 4**-----

Consider a diverging lens with a focal length of **2 cm**.

1. Determine, by calculation and graphical construction, the position of the image $A'B'$, given by this lens, of a real object AB placed at the image focus F' of the lens, perpendicular to its axis.
2. What is the nature of the image? Calculate its length $\overline{A'B'}$.

Exercise 5**-----

An object AB , **5 mm** long, is placed at a distance OA in front of a thin converging lens with center O and focal length $OF' = 2 \text{ cm}$. Since the object is perpendicular to the axis of the lens, its image $A'B'$, given by the lens, will be formed at a distance OA' from center O .

1. Recall the relationship between distances OA, OA' , and OF' .
2. Where should the object AB be placed to form an image $A'B'$ on a screen placed at a distance $3OF'$ from the lens?

3. Construct a geometric structure of the object-lens-image system.

4. What are the nature and magnitude of image $A'B'$?

Exercise 6-----

We place two lenses with optical power of $+5 \delta$ and -2δ together. We want to form on a screen, using this optical system, an image reduced by **50%**, of a real object. How should we position the object, the set of two lenses and the screen?

Exercise 7**-----

1. Two lenses L_1 and L_2 , with focal lengths $f_1 = 2 \text{ cm}$ and $f_2 = 4 \text{ cm}$, respectively, are placed together. Calculate C_T the optical power of the doublet, in m^{-1} .

2. Using the two lenses, a doublet is formed by separating them by a distance $O_1O_2 = 10 \text{ cm}$, where O_1 and O_2 are the respective optical centers of L_1 and L_2 . An object $AB = 1 \text{ cm}$ is placed perpendicular to the axis of the doublet, **3 cm** in front of L_1 .

a- Calculate the position O_1A_1 and the magnitude of the image A_1B_1 given by lens L_1 . Represent it graphically.

b- What is the position O_2A_1 of the image A_1B_1 ?

c-Determine by calculation and graphically the final image A_2B_2 .

Exercise 8**-----

An object AB , **9 mm** long, is placed **12 cm** in front of a diverging lens L_1 with a focal length $f_1 = 6 \text{ cm}$, perpendicular to its optical axis.

1. Determine its image A_1B_1 .

2. Place another thin converging lens L_2 **4 cm** behind L_1 , with a focal length $f_2 = 4 \text{ cm}$, so that their optical axes coincide.

a- Determine the image $A'B'$ of AB through L_1 and L_2 .

b- Trace the path of a light beam, originating from B (A is on the optical axis), and passing through the system L_1L_2 in the following two cases:

— Taking into account the intermediate image A_1B_1 .

— Ignoring A_1B_1 .

Exercise 9-----

A real object AB is in the focal plane of a converging lens with focal length $f' = 10 \text{ cm}$. A plane mirror M is placed **10 cm** from the lens and perpendicular to its optical axis. Find, graphically, the characteristics of the image produced by the lens-mirror system.