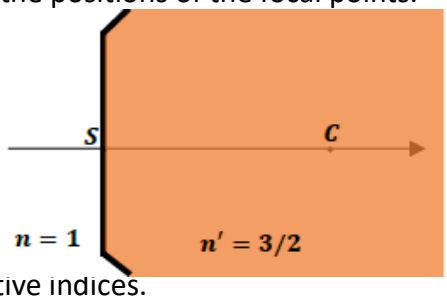
Faculty of matter Sciences and Computer Science
Department of Physics – L2_Physics
Exercise Series of Geometrical and Physical Optics, 2025-2026
Exercise Series Number 3: Diopters and thin lenses

Exercise N°1:

1- A convex spherical diopter with a radius of curvature of 10 cm separates two media with refractive indices n=1 and n'=3/2 (see figure). Determine the positions of the focal points.

2- Calculate and draw the position of the image of an object AB placed at:

- 60 cm from the vertex (real object)
- 10 cm from the vertex (real object)
- 5 cm behind the diopter (virtual object)



3- Repeat the same questions after interchanging the refractive indices.

Exercise N° 02:

A concave spherical diopter with vertex S and radius R $(R = \overline{SC})$ separates two media with refractive indices n_1 and n_2. Given: $n_1 = 1.5$ and $n_2 = 1$

1. Determine the positions of the focal points F and F' and specify their nature.
2. Construct, geometrically, the image of a real object perpendicular to the diopter axis in the following two cases: $\overline{SA} = 4R$ and $\overline{SA} = 2R$.
3. Calculate the linear magnification for each of these two cases.

Exercise N° 03:

Consider a glass sphere of radius $R = 10\ cm$ and refractive index $n = 1.5$. An object AB is placed to the left of the sphere, at a distance $d = 120\ cm$ from the entrance face.

1. Determine the position of the image of the object using the spherical diopter conjugation formula.
2. Determine the object and image focal points of the sphere.
3. Calculate the position of the object such that the object and image distances, relative to the sphere, are equal.

Exercise N° 04:

A vase with a horizontal bottom contains two immiscible liquids. The lower liquid has a thickness $e_1 = 20\ cm$ and a refractive index . The upper liquid has a thickness $e_2 = 10.5\ cm$ and a refractive index . A fish is located $4\ cm$ above the bottom of the vase.

- ✓ At what apparent distance does the fish seem to be (closer or farther), for an observer whose eye is in the air above the liquids?

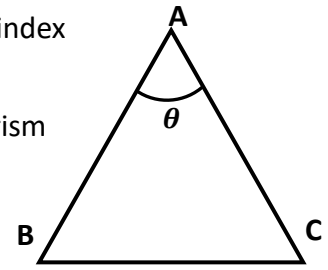
Exercise N° 05:

A spherical diopter with vertex S and radius $40\ cm$ separates air from glass of refractive index $n = 1.48$. Its center C lies in the glass.

1. Determine the object and image focal distances of this diopter.
2. Determine the position and magnification of the image A' of a real object located $30\ cm$ from the vertex S.
3. Determine the position and magnification of the image A' of a virtual object located $30cm$ from the vertex S.

Exercise N° 06:

A prism with cross-section ABC, apex angle $\theta = 60°$, and refractive index $n = 1.5$ is immersed in air ($n' = 1$).



1. Calculate the emergence angle i' of a light ray entering the prism with an incidence angle $i = 30°$.
2. Draw the path of this incident ray.

Exercise N°07:

A monochromatic light ray enters a prism with an apex angle $A = 30°$ and refractive index $n = 1.5$. The prism is placed in air ($n' = 1$).

1. Determine the angles of incidence (i), emergence (i'), and the total deviation D_t for each of the following situations:
    a. Normal incidence.
    b. Grazing (parallel) incidence.
    c. Minimum deviation $(i = i')$
    d. Normal emergence,
    e. Grazing emergence.
2. Plot the graph $D_t = f(i)$, showing how the total deviation of the incident ray varies as a function of the incidence angle i.

Exercise N°08:

A prism with apex angle $A = 30°$ and cross-section ABC is struck perpendicularly on face AB by a monochromatic light ray. The prism is immersed in air $(n' = 1)$.
After emerging from the prism, the total deviation experienced by the ray is $D_T = 30°$.

1. Determine the refractive index n of the prism.
2. For a prism made of the same material but with apex angle $A' = 60°$, what would be the minimum deviation D_{min}?

Exercise N° 09:

A prism of glass, with refractive index n= 1.5, is placed in air. Its base is an equilateral triangle.

1. Show that the deviation is minimal for $r = r' = \frac{\theta}{2}$
2. Calculate the angle of minimum deviation D_m.

3. We then immerse this prism in water $(n_e = 1.33)$; What is the new minimum deviation angle D'_m?

Exercise 10:

1- A converging lens has a focal length $f = 20\ cm$.

a. Express this focal length in meters.
b. Gives the expression and unit of the vergence of a converging lens.
c. Calculate the vergence of this lens.

2- We want to represent this lens, its optical center, and its focal points on graph paper at a scale of .

a. Determine the focal length of the lens on the drawing.
b. Draw this lens and its focal points on the graph paper.

3- A lens has a vergence $C = -50\ \delta$.

a. What type of lens is it? Justify your answer.
b. Calculate the focal length.
c. Draw this lens, its principal optical axis, and its two focal points

Exercise 11:

Let L be a converging lens with image focal length f', its focal length is $f = 3\ cm$. An object AB of height $1\ cm$ is placed at a distance of $5cm$ from the lens and perpendicular to the optical axis O.

- **Case 1:** the object is placed 5 cm from the optical center: $OA = 5\ cm$
- **Case 2:** the object is placed 3 cm from the optical center: $OA = 3\ cm$
- **Case 3:** the object is placed 2 cm from the optical center: $OA = 2\ cm$

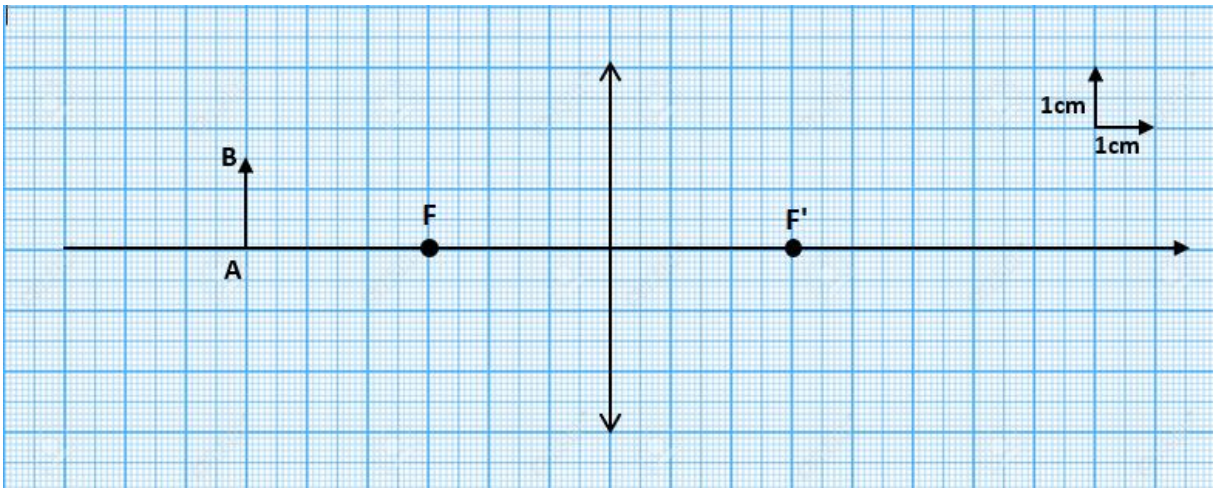
1- Construct the image A'B'A'B'A'B' of the object ABABAB formed by this converging lens for each case.

2- Determine the distance OA'OA'OA', the size of the image $A'B'$, and the characteristics of this image for each case.

Exercise N° 12:

We consider the diagram below.

1. From the diagram, determine the focal length f of this lens.
2. Calculate the vergence C of this lens.
3. In the previous diagram, we place an object AB=1.5 cm at a distance OA=6cm
    a. Plot the image A'B' of the object AB in the previous diagram.
    b. Determine the characteristics of the image A'B'.
    c. The object AB is moved closer so that the distance OA=2 cm. Determine the characteristics of the image A'B'.



Exercise 12 :

Let L_1 be a lens with optical center $O1$ and vergence $V_1 = 20\ \delta$. A screen E, parallel to this lens, is placed at a distance $d = 3m$. We want to project, through this lens, a square slide of $3\ cm$ on each side, placed parallel to this lens.

1. Where should the slide be placed to obtain a sharp image on the screen E ?
2. What is the size of this image?
3. If lens L_1, is replaced by another lens L_2 of vergence V_2. Show that, in order to obtain a very large magnification ($|\gamma| \gg 1$), the vergence V_2 must satisfy the relation: $V_2 = -\frac{\gamma}{D}$ where D is the distance between the object and its image.
4. What vergence V_2 Should we choose to project the slide on screen E, with the screen located 2.5 m from the slide, and with a magnification of about -50?
5. Where should the slide be placed relative to the optical center O_2 of L_2 ?
6. What is the size of the image obtained?