Selection of exercises on paraxial approximation

Constructions with thin lenses

*We choose at random an object and an image with their relative positions and sizes : determine by contruction the lens (position and focal length) that can perform this imaging. Specify if the object and image are real or virtual.

*For a converging lens with a fixed focal length, construct the couple of conjugate points with a transverse magnification of +2 then of -2. Same questions with a diverging lens.

Constructions for a focal system using its cardinal points

We consider an optical system with the following characteristics:

- Power P=50 diopters (1 diopter = 1 m^{-1})
- indices in object and image spaces: n=1, n'=1.5
- distance between principal planes: $\overline{HH'} = 1$cm

Construct to scale (one separate drawing for each construction, scale 1:1 along x and 10:1 along y):

(1) all the cardinal points of the system F F' H H' N N';

(2) the image of an object A such that $\overline{FA} = -1$cm;

(3) the image of an object A such that $\overline{FA} = +10$cm;

(4) the image of a disc with radius y=1.5mm centered on the optical axis, placed in the first (object) focal plane; determine the size of its image;

(5) the object which has an image A' with $\overline{H'A'}$=5cm;

(6) construct the two points with transverse magnification −1, then those with angular magnification −1

(7) draw a non specific incident ray and construct the corresponding emerging ray;

(8) draw a non specific emerging ray and construct the corresponding incident ray.

Do the same problem with a system with P= −50 diopters, then with P=+50 diopters but with $\overline{HH'} = -1$cm.

Shape of plano convex lens with a given focal length

Determine the geometrical characteristics of plano-convex with focal length 100mm made of a glass with index n=1.5187, and with a diameter of 30 mm. You will first neglect the thickness of the lens to calculate the radius of curvature of each surface, then you will allow a minimum thickness of 2mm (either at the center or on the edge depending on the type of lens) and calculate the variation of the focal length due to this thickness.

Determine the principal planes and the focii for this lens.

Cardinal points of a sphere of glass

Construct and then calculate all the cardinal points and focal length of a spherical lens with diameter 5 mm and index of refraction n=1.84, used in air. How are its characteristics changed when it is immersed in water with index 4/3?

Basic applications of Gullstrand's formula:

How should you arrange two thin lenses with the same optical axis so that the power of the whole system is equal to:

a) the sum of the individual powers?

b) the power of the first lens minus the power of the second lens? Is it always possible? Do the drawing in the case when $f'_2 = -f'_1$. Determine H, H', F and F' (same for $f'_2 = f'_1/2$)