

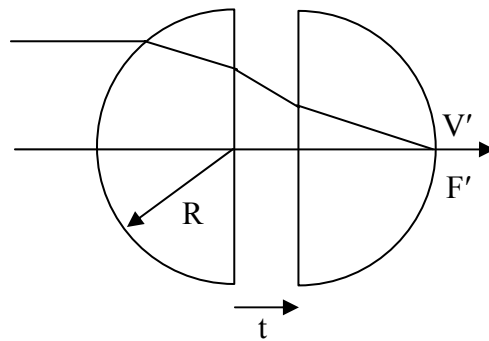
Assigned: 9/27/11 Lecture 11  
Due: 10/06/11 Lecture 14 (3 Lectures)

This HW set is worth 15 total points.

6-1) A lens assembly is made up of two identical thin lenses separated by 25 mm, and the focal length of each thin lens is 50 mm. Fixed object and image planes are separated by 150 mm. What are the two possible image magnifications that can be obtained with this lens assembly? Use Gaussian methods.

6-2) Earlier, we found that a sphere with an index of 2.0 is needed for light from a distant object to be focused by the front surface of the sphere onto the opposite side of the sphere. Unfortunately an index of 2.0 is difficult to obtain.

A solution to obtain this same effect is to split a sphere into two identical hemispheres. What separation between the hemispheres is required to have the light from a distant object focus on the vertex of the second hemisphere?  $F'$  is to be coincident with  $V'$ . The radii of the hemispheres are 50 mm, their indices are 1.5, and the hemispheres are in air. Use Gaussian methods.

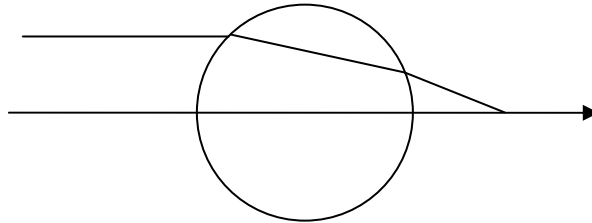


6-3) Do a paraxial raytrace of the following thin lens system (this is called a reverse-telephoto lens configuration) to determine the system power and the locations of the rear cardinal points ( $F'$ ,  $P'$ ). Check your answers with Gaussian Reduction. Sketch the result.

$$\begin{aligned} f_1 &= -63.6364 \\ f_2 &= 34.7222 \\ t &= 50 \end{aligned}$$

6-4) A spherical crystal ball has a diameter of 50 mm and an index of refraction of 1.5. The ball is used as a lens (in air).

Use paraxial raytrace methods to determine the power of the ball, its back focal distance, and the location of the rear principal plane.



6-5) Use a paraxial raytrace to determine the Gaussian properties of the eye model from the earlier problem ( $\phi, f_F, f'_R, F, F', P, P'$ ; do not trace rays to determine the nodal point).

Do your answers agree with Gaussian reduction?

Dimensions are in mm. The front of the eye is in air.

	r	t	n
1	7.8	3.6	1.336
2	10.0	3.6	1.413
3	-6.0		1.336

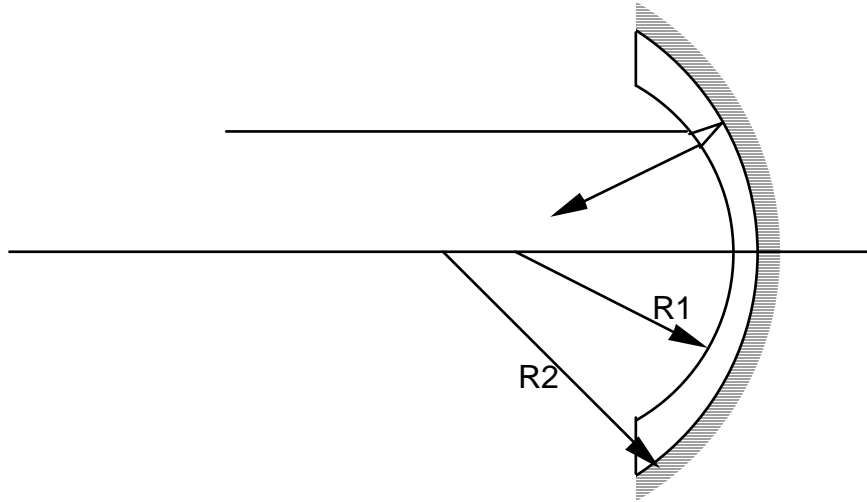
6-6) Do a paraxial raytrace of a biconcave lens. The lens thickness is 5 mm, and its index is 1.5. The curvatures are  $C_1 = -.01/\text{mm}$  and  $C_2 = .01/\text{mm}$ .

a) Determine its Gaussian properties.

b) An object of height 10 mm is located 100 mm to the left of the first surface. Trace two rays (one at  $h = 0$  and one at  $h = 10$ ) to determine the image location and size. Sketch the ray paths.

c) Repeat for a virtual object 150 mm to the right of the first vertex.

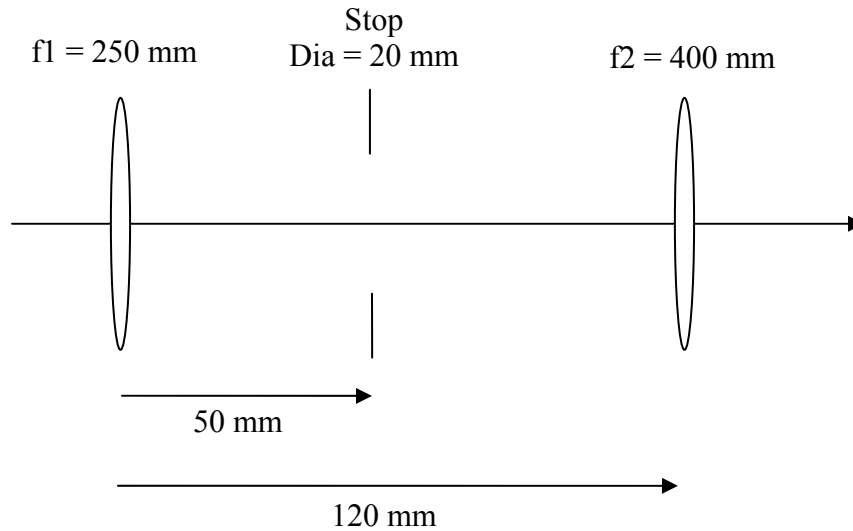
6-7) A Mangin mirror consists of a second surface spherical reflector, with a different first surface curvature. (See figure):



Specifications:  $R_1 = 100.0$     $R_2 = 150.0$     $t = 10.0$     $n = 1.5$

- Do a paraxial ray trace of this Mangin mirror to determine the effective focal length, rear principal plane location, and back focal distance.
- Where is the front principal plane, and where is the front focal point?

6-8) Given the following optical system in air, use paraxial raytrace methods to determine the location and size of the entrance pupil and the exit pupil. Both lenses are thin lenses. Use a raytrace sheet to trace the rays, and sketch the pupils on system drawing.



6-9) Repeat the above problem using Gaussian methods.

6-10) A 25 mm diameter sensor is used with a 50 mm focal length optical system to image a distant scene. What is the angular FOV of the system? The system is in air.

