

Assigned: 9/20/11      Lecture 9  
Due: 9/27/11      Lecture 11

## Reminders:

Midterm: Thursday 10/20      Lecture 18  
Last Class: Tuesday 12/6      Lecture 30  
In Class Final: Tuesday 12/13      8:00-10:00 AM

No exceptions – Plan your holiday travel accordingly

All course materials for Distance Learning Students must be received in Tucson by Monday December 19, 2011.

5-1) The following combination of thin lenses in air is in a telephoto configuration:

$f_1 = 75 \text{ mm}$   
 $f_2 = -60 \text{ mm}$   
Spacing = 35 mm

Use Gaussian reduction to determine the focal length of the system, and the locations of the rear principal plane and the rear focal point.

5-2) A thick lens in air has the following specifications:

$R_1 = 127 \text{ mm}$   
 $R_2 = -77 \text{ mm}$   
 $TH = 17 \text{ mm}$   
 $n = 1.472$

- What is the focal length and power of this lens? Where is the image of an object at infinity located with respect to the rear vertex of the lens (the back focal distance)?
- What are the focal length, power and back focal distance if the index of the lens is changed to 1.853?
- What are the rear focal length, focal length, power and back focal distance if the original lens ( $n = 1.472$ ) is immersed in water ( $n = 1.333$ )?

Use Gaussian reduction for this problem.

5-3) Use Gaussian reduction to determine the back focal distance of the following three surface optical system:

$$n = n_0 = 1.33$$

$$R_1 = 25.0$$

$$n_1 = 1.50$$

$$t_1 = 5.0$$

$$R_2 = -40.0$$

$$n_2 = 1.60$$

$$t_2 = 5.0$$

$$R_3 = -60.0$$

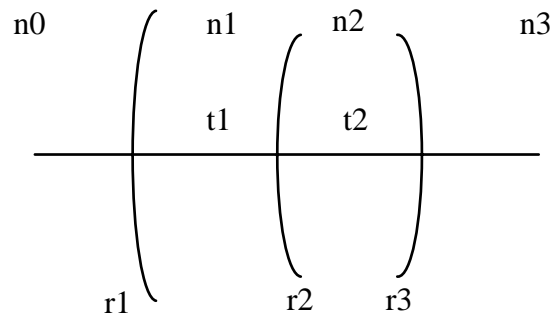
$$n' = n_3 = 1.33$$

5-4) Determine the Gaussian properties of a thick lens in air with a first surface of radius  $r_1$ , a thickness  $t$ , an index  $n$ , and a second surface of radius  $r_2$  such that:

- it is concentric with the first surface.
- it has equal but opposite power from the first surface.
- the lens has zero power.

For each of these three cases, determine the Gaussian properties of the lens and sketch the locations of the cardinal points ( $\phi, f_F, f'_R, P, P', F, F', N, N'$ ).

5-5) Using Gaussian reduction, determine the Gaussian properties of the following eye model. Dimensions are in mm. The front of the eye is in air. Keep a copy of your answers for future use.



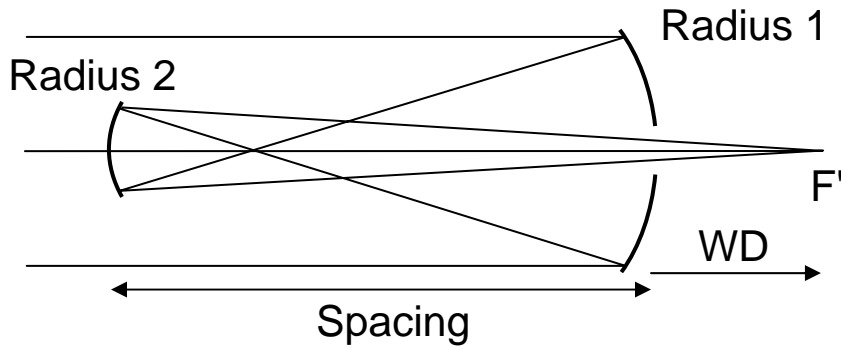
	<u>r</u>	<u>t</u>	<u>n</u>
1	7.8	3.6	1.336
2	10.0	3.6	1.413
3	-6.0		1.336

5-6) A concave mirror with a radius of curvature of 100 mm is used to image a real object 200 mm away from its vertex. Where is the image and what is the magnification? Work this problem using the sign conventions of class.

Note: You must put the above information into the proper sign convention. Don't expect your customer to know about sign conventions.

5-7) A mirror of curvature  $C$  is immersed in an index  $n$ . What is its power, and what are the front and rear focal lengths? Which depend on  $n$ , and which do not?

5-8) A Gregorian objective is an all reflective system that uses two concave mirrors:



$$\text{Radius 1} = 100 \text{ mm}$$

$$\text{Radius 2} = 40 \text{ mm}$$

$$\text{Spacing} = 75 \text{ mm}$$

- Use Gaussian reduction to determine the focal length and working distance (WD) for this system.
- You should have found that this system has a negative power and focal length, yet it forms a real image. Explain this result. Consider the ray path for the ray for an object at infinity and the definitions of the cardinal points.