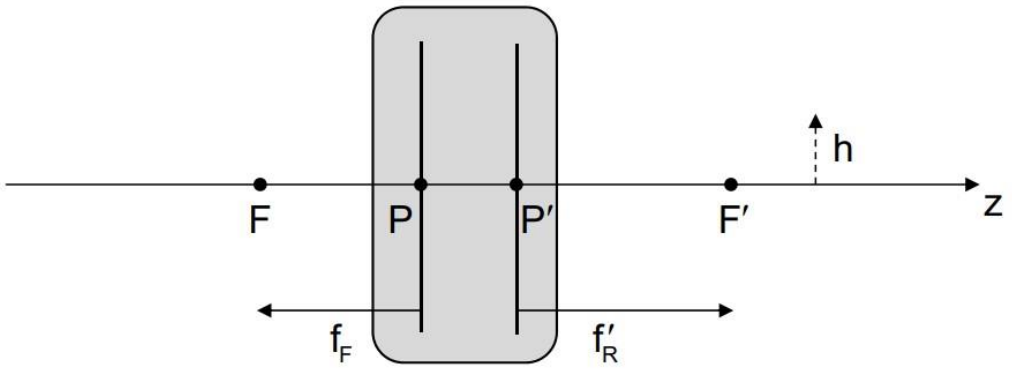
Homework 5

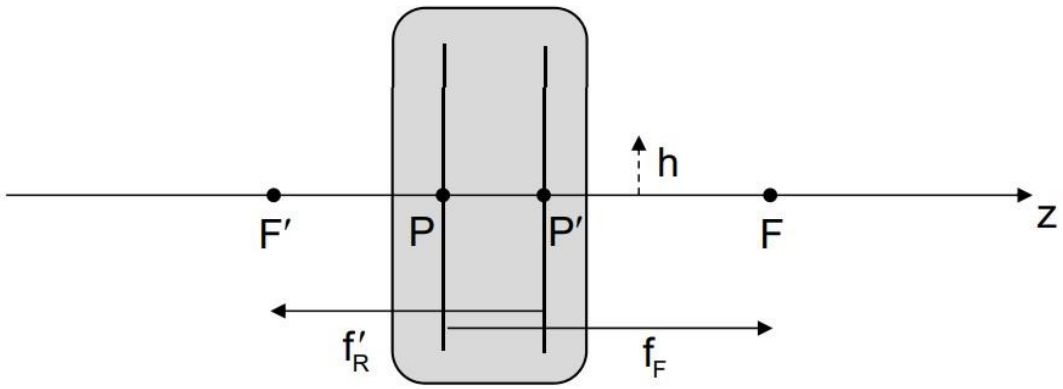
1. Virtual Images: Optical System Ray Diagrams

For the following optical systems, complete the ray diagram. Indicate whether the image is real or virtual and where it is approximately imaged.

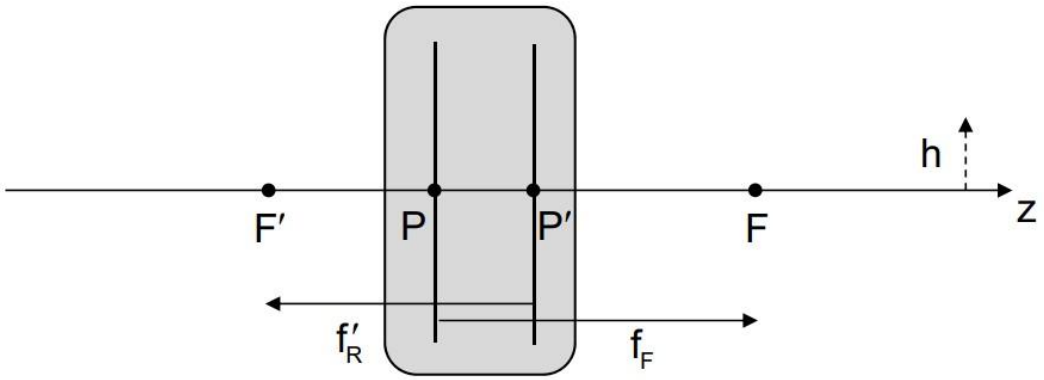
(a) Virtual image beyond (to the right of) the F' plane for a positive focal length system.



(b) Virtual image between the P' and F plane for a negative focal length system.



(c) Virtual image beyond (to the right of) the F plane for a negative focal length system.


h
z
F′
P
P′
F
f′R
fF

2. Gaussian Imaging: Refracting Surface

Consider a refracting surface with radius of curvature +10.0mm. Rays begin in air ($n = 1.000$), hit the refracting surface, then continue through a medium ($n' = 1.333$). Use Gaussian imaging for this question.

(a) Calculate and illustrate the exact positions of the following planes for this system: F, F', P, P', N, N', V, CC.

(b) A real 10.0mm height object is now placed 100mm in front (to the left) of the principal plane P. Where is the image located and what is its height?

(c) A 10.0mm cube is now placed with the centre of the cube being 105mm from the principal plane and centred on the optical axis. What are the physical (not air equivalent) dimensions of the image of the cube? Do not use an approximation for longitudinal magnification.

Two Positive Lens Configuration

Find the location of the planes P, P', F, F' in addition to the BFD and FFD for a two positive lens configuration. You must use Gaussian reduction.

$$f_1 = +40mm$$

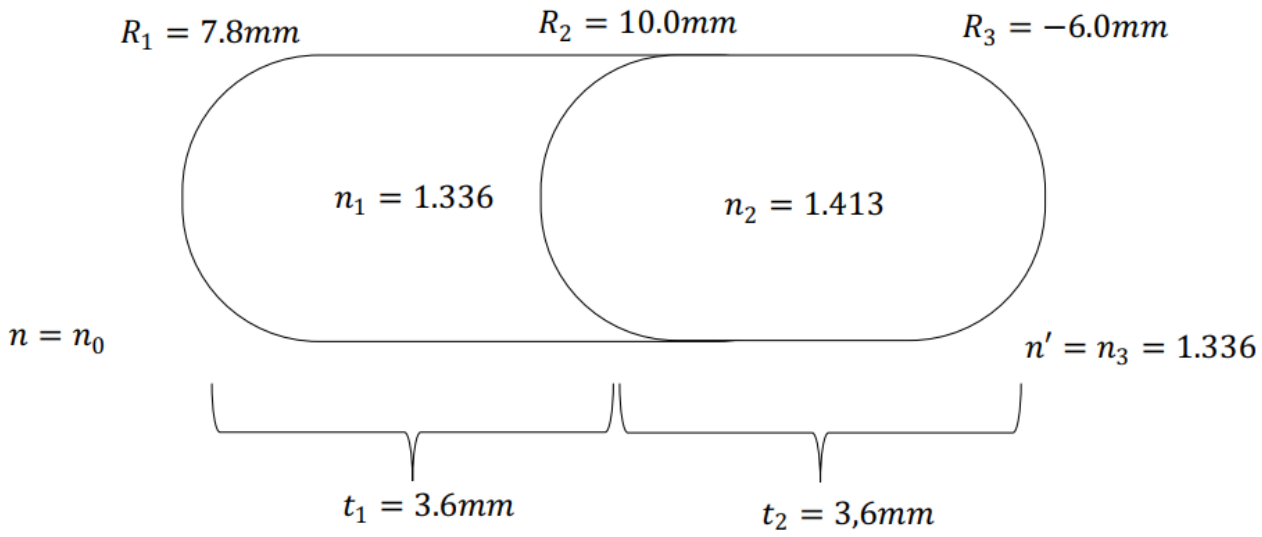
$$f_2 = +40mm$$

$$t = 20mm$$

Assume this configuration is in air with $n = 1.00$.

Eye Model

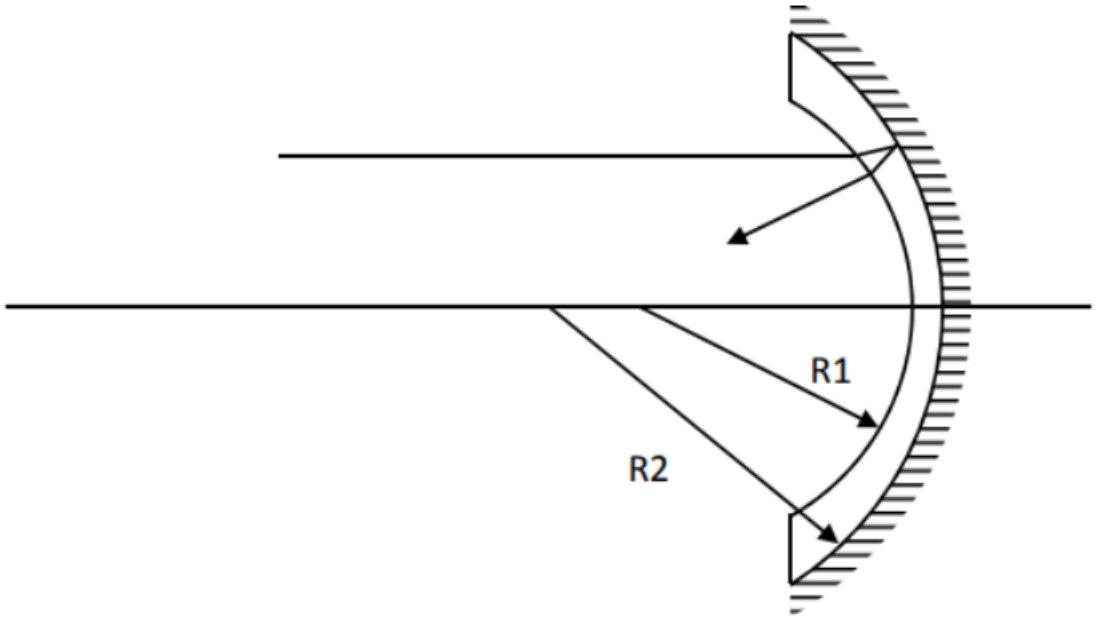
Using Gaussian reduction, determine the Gaussian properties (position of P and P' planes from vertices 1 and 3; F, F', N and N' planes from the P, P' planes) of an eye model. If the front of the eye is in air ($n = 1.00$).



Repeat using paraxial raytracing. (Do not determine the nodal points).

Paraxial Raytrace: Mangin Mirror

A Mangin mirror consists of a second surface spherical reflector, with a different first surface curvature.



$$R_1 = 100.0mm, \qquad R_2 = 150.0mm, \qquad t = 10.0mm, \qquad n = 1.5$$

a. Do a paraxial ray trace of this Mangin mirror to determine the effective focal length, rear principal plane location, and back focal distance.

b. Where is the front principal plane, and where is the front focal point?