

HW #1: Due Feb. 2, 2015**Problem 1 (30 pts):**

Show that the ellipsoidal surface of revolution in Fig. 1 will give perfect image formation with refraction for the parallel beam at the focus F' of the ellipse provided that the eccentricity $e = c/a$ satisfies $e = n/n'$. NO paraxial approximation.

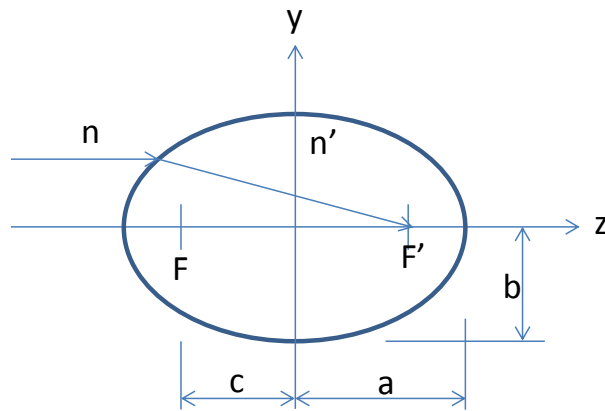


Fig. 1

Problem 2 (30 pts):

A plane wave is incident from air onto a bi-convex thin lens having radius $|R1|=|R2|=R$ that has an index of refraction of n . Derive an expression for the wave surface after refraction by the thin lens. Express your answer in terms of the radial distance (r) from the optical axis (z) that is defined as the original propagation direction of the plane wave through the point of first contact of a wavefront with the lens.

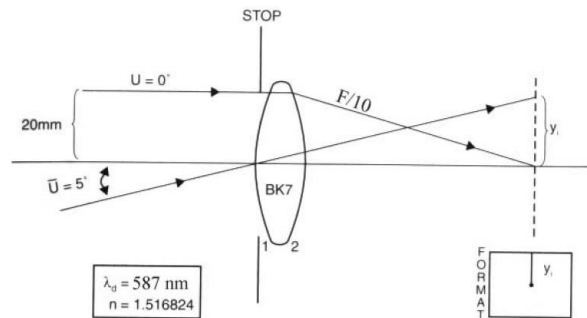
Hint: Assume that deflection of the ray at the two surfaces are negligible.

Problem 3 (18 pts):

With the information provided in the figure below, find:

- The effective focal length (EFL),
- The lens power ϕ ,
- Surface curvatures $C1$ and $C2$ (assume an equi-convex lens).
- Radius of curvatures $R1$ and $R2$,
- Format size (assume square), and
- Airy disk diameter.

Note: The lens can be considered as a thin lens.

**Problem 4 (9 pts):**

An achromatic doublet consists of a crown glass positive lens of index 1.52 and of thickness 1 cm, cemented to a flint glass negative lens of index 1.62 and of thickness 0.5 cm. All surfaces have a radius of curvature of magnitude 20 cm. If the doublet is to be used in air, determine:

- The system matrix elements for input and output planes adjacent to the lens surfaces;
- The cardinal points;
- The focal length of the combination, using the lensmaker's equation and the equivalent focal length (f^*) of two lenses in contact. Compare this calculation of f^* , which assumes thin lenses, with the previous value.

Problem 5 (9 pts):

($D_2 - 10.7$) Using a ray from infinity, ray trace this marginal ray ($y = 1$) through the lens below.

Determine:

- The back focal distance (BFD).
- The effective focal length (efl).
- The location of the principal planes (P and P^*) relative to V_1 .

