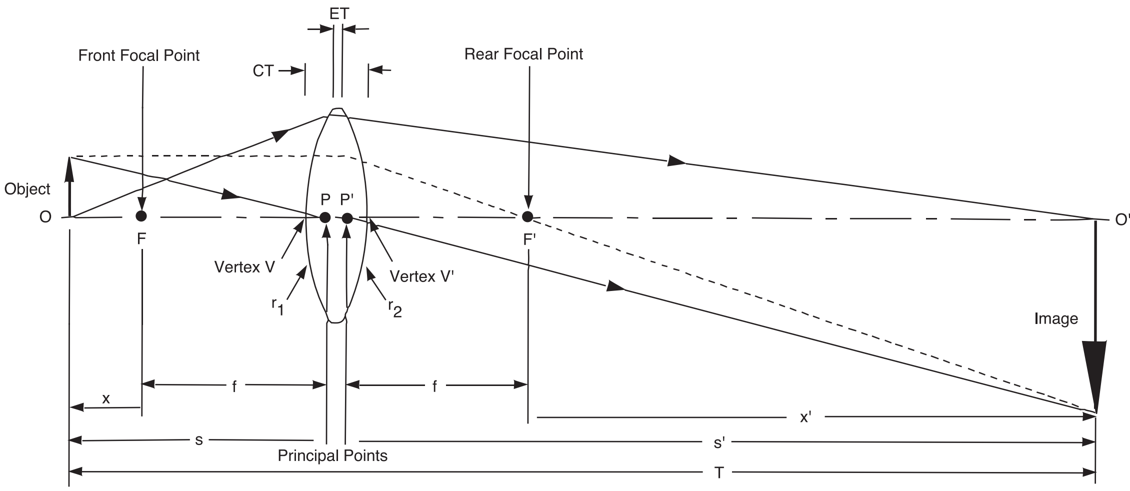

The convention used here is:–

s +ve if direction PO is to the right
s' +ve if direction P'O' is to the right
x +ve if direction FO is to the right
x' +ve if direction F'O' is to the right
m –ve if image is inverted
radii +ve if center lies to the right of surface

The focal length f of a thick lens may be calculated using the following formula

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right) + \frac{(n-1)^2\,CT}{n r_1 r_2}$$

The principal plane positions may then be found from

$$VP = \frac{-CT\,(n-1)f}{n r_2} \quad \text{or} \quad V'P' = \frac{-CT\,(n-1)f}{n r_1}$$

The magnitude of sag drop on the surface is given by

$$Sag = \{\,|R| - (R^2 - D^2/4)^{1/2}\}$$

where R is the radius of the curvature of that surface and D the diameter of the component.

Many expressions in optics are simplified by considering the power K, given by

$$K = 1/f$$

A common unit of lens power is the diopter which is the power of a lens with a focal length of 1 meter.

In many cases, the center thickness CT produces a second order change to the overall focal length. For a change in wavelength, the focal length f_λ' at a new wavelength λ' can be calculated from the initial focal length f_λ at wavelength λ by the following equation

$$f_\lambda' = f_\lambda\left(\frac{n_\lambda - 1}{n_\lambda' - 1}\right)$$

Example 1

To determine the magnification and image position of a BK7 Plano-Convex Lens for an object located 200mm from the curved face

The first principal point P for this lens is located at the curved surface as VP = 0.

Taking into account the sign convention s = –200 mm.
The nominal focal length f = 40mm.

Using the equations on Theory Pg 1 and the information given

s’ = fs/(f+s)
= 40.(–200)/(40+(–200))
= 50mm (measured from P’)

Given V’P’ = –1.6mm the paraxial image is formed 48.4 mm from the plano face of the lens.

Magnification m = s’/s
= 50/(–200)
= –0.25 (the image is inverted)

Example 2

Solving the same problem using the Newton conjugate equations

x = s+f = –200+40 = –160 mm
x’= – f^2/x = $-(40)^2$/(–160) = 10 mm
m = f/x = 40/(– 160) = –0.25
s’ = x’+f = 10+40 =50 mm