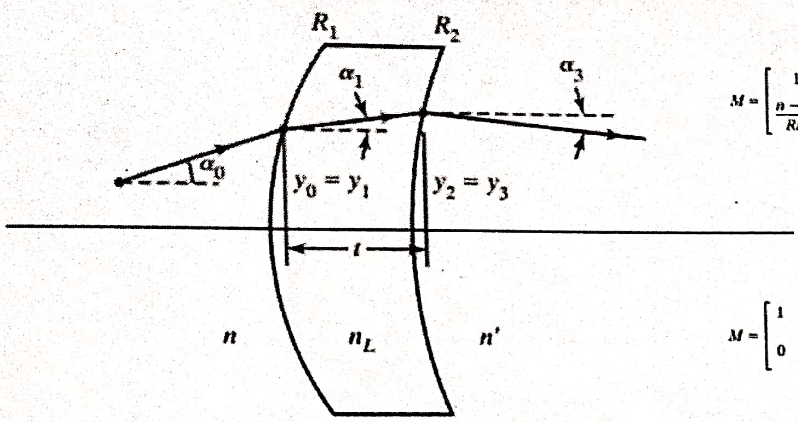
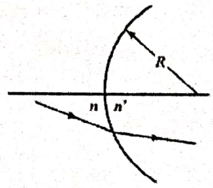
Name : ______________

Enrollment No. ____________

Find the system matrix for the thick lens. Specification of the thick lens is given as $R_1 = 45$ cm, $R_2 = 30$ cm, $t = 5$ cm, $n_L = 1.60$ and $n=n'=1$.

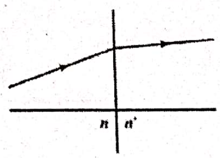


$$M = \begin{bmatrix} 1 & L \\ \frac{n-n'}{Rn'} & \frac{n}{n'} \end{bmatrix} = \Re$$



(+R) : convex
(−R) : concave

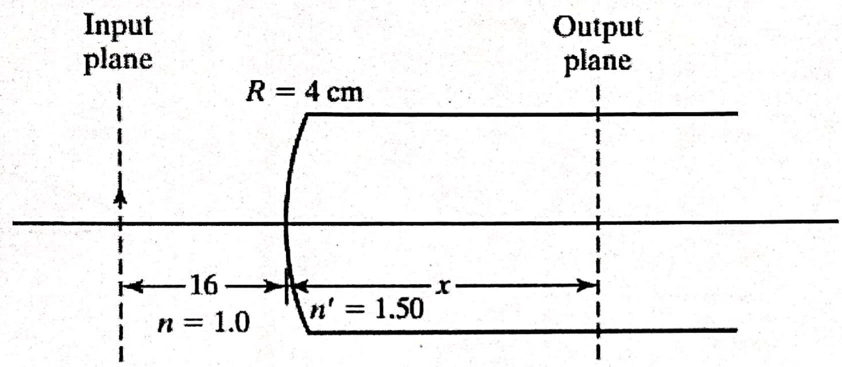
$$M = \begin{bmatrix} 1 & 0 \\ 0 & \frac{n}{n'} \end{bmatrix}$$



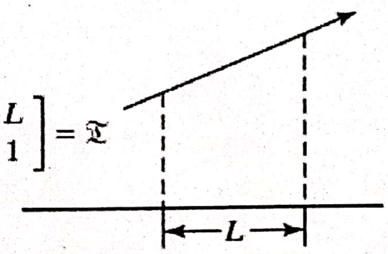
$$M = \begin{bmatrix} 1 & 0 \\ \frac{1}{50} & 1.6 \end{bmatrix} \begin{bmatrix} 1 & 5 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -1/120 & 1/1.6 \end{bmatrix}$$

$$\text{or } M = \begin{bmatrix} 23/24 & 25/8 \\ 7/1200 & 17/16 \end{bmatrix}$$

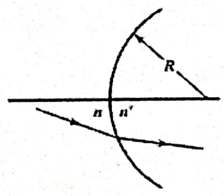
We place a small object on axis at a distance of 16 cm from the left end of a long, plastic rod with a polished spherical end of radius 4 cm, as indicated in Figure 10. The refractive index of the plastic is 1.50 and the object is in air. Let the unknown image be formed at the output reference plane, a distance x from the spherical cap. We wish to determine the image distance x and the lateral magnification m. The system matrix connecting the object and image planes consists of the product of three matrices, corresponding to (1) a translation in air from object to the rod, (2) a refraction at the spherical surface, and (3) a translation in plastic to the image.



$$M = \begin{bmatrix} 1 & L \\ 0 & 1 \end{bmatrix} = \mathfrak{T}$$



$$M = \begin{bmatrix} 1 & L \\ \frac{n - n'}{Rn'} & \frac{n}{n'} \end{bmatrix} = \mathfrak{R}$$



(+R) : convex
(−R) : concave

$$M = \begin{bmatrix} 1 & x \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1-1.50}{4(1.50)} & \frac{1}{1.50} \end{bmatrix} \begin{bmatrix} 1 & 16 \\ 0 & 1 \end{bmatrix}$$

$$M = \begin{bmatrix} 1 - x/12 & 16 - 2x/3 \\ -1/12 & -2/3 \end{bmatrix}$$

$B = 0$ for linear magnification

$16 - \frac{2x}{3} = 0 \qquad x = 24\,cm$

$\therefore$ magnification $m = A = 1 - \frac{x}{12} = -1$

$\Rightarrow$ image at 24cm inside the rod, is inverted and has the same size.