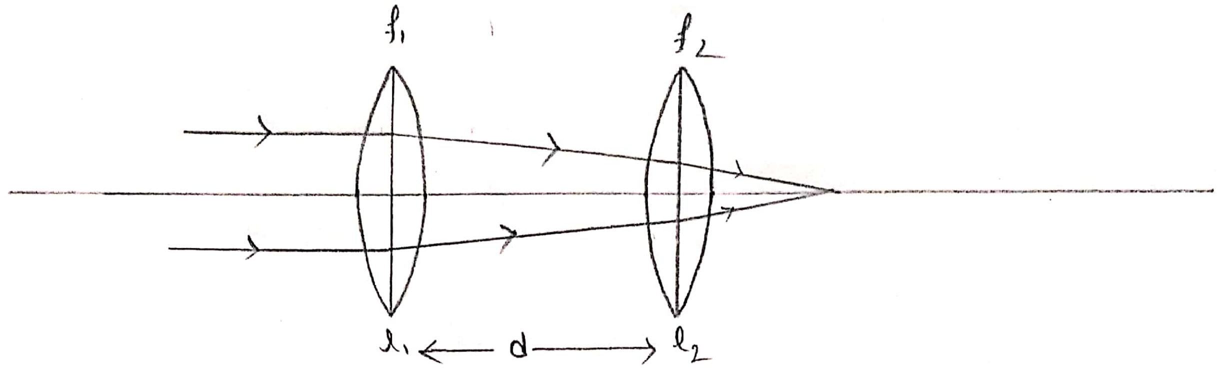
Dasgupta B.Sc Phy. III Sem.

Abhipsa Paul
Roll No. - 01
3rd Semester

Assignment - 2

ASSIGNMENT - 2

Find the position of two principle points, two focal points & two nodal points for a combination of two convex lens of focal length 20 cm and 10 cm situat-ed at a distance 10 cm apart in air.



∴ The focal length of the combination of lens =

$$\frac{1}{f_{eq.}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

$$= \frac{1}{10} + \frac{1}{20} - \frac{10}{10 \times 20}$$

$$= \frac{1}{10}$$

∴ $f_{eq.} = 10$ cm.

∴ The separation between principle points $= F \times \frac{d}{f_1 \cdot f_2}$

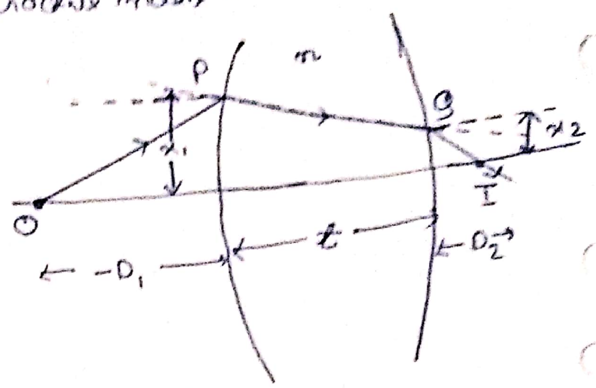
$$= 10 \times \frac{10}{20 \cdot 10} \text{ cm}$$

$$= 0.5 \text{ cm}$$

Ashes Dasgupta B.Sc Phy. III Sem.

Assignment 1 :→ System matrix of two thin lens separated by some dist. d

Let us consider a lens of thickness t of refractive index n & Radius of Curvature R_1 & R_2.



Here the system matrix (say S) is given by,

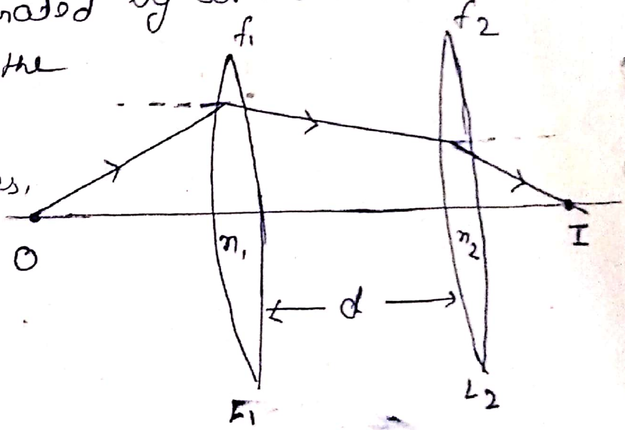
$$S = \begin{bmatrix} b & -a \\ -d & c \end{bmatrix} = \begin{bmatrix} 1 & -P_2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ t/n & 1 \end{bmatrix} \begin{bmatrix} 1 & -P_1 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 - \frac{P_2 t}{n} & -P_1 - P_2\left(1 - \frac{t}{n}P_1\right) \\ t/n & 1 - \frac{t}{n}P_1 \end{bmatrix}$$

For thin lens, $t \to 0$, So, we have,

$$S = \begin{bmatrix} 1 & -P_1 - P_2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & -1/f \\ 0 & 1 \end{bmatrix}$$; where $f = \frac{1}{P_1 + P_2}$ is the focal length of the lens.

Now considering two thin lens separated by some dist. d.



Let f_1 be the focal length of lens 1 & f_2 be the focal length of lens L_2.

we have, the matrices of the two lens as,

$$\begin{bmatrix} 1 & -1/f_1 \\ 0 & 1 \end{bmatrix} \ \& \ \begin{bmatrix} 1 & -1/f_2 \\ 0 & 1 \end{bmatrix}.$$

we have the translation matrix as,

$$\begin{bmatrix} 1 & 0 \\ d & 1 \end{bmatrix}.$$

∴ The system matrix S is given by,

$$S = \begin{bmatrix} 1 & -1/f_2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ d & 1 \end{bmatrix} \begin{bmatrix} 1 & -1/f_1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} (1 - d/f_2) & -\left(\frac{1}{f_1} + \frac{1}{f_2} - \frac{1}{f_1 f_2}\right) \\ d & \left(1 - \frac{d}{f_1}\right) \end{bmatrix}$$

Thus, we have, $a = \frac{1}{f_1} + \frac{1}{f_2} - \frac{1}{f_1 f_2}$, $b = 1 - \frac{d}{f_2}$; $c = 1 - \frac{d}{f_1}$, $d = -d$

BANWARILAL BHALOTIA COLLEGE

[PHYSICS DEPARTMENT]

Assignment-1, Major Optics

3rd Semester

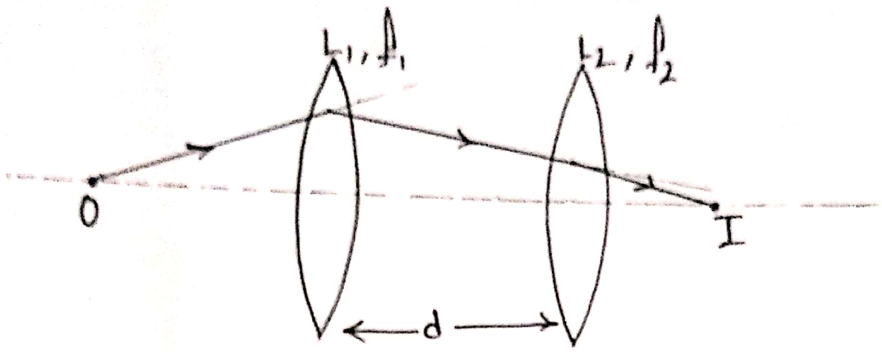
Topic: Find the system matrix of two thin lenses separated by distance.

Student's Name: Sangita Pal.

Roll No.: 18

Find the System Matrix of two thin lenses separated by distance. :

Ans.:



Let's consider a optical system consisting of two thin lenses, — L_1 and L_2 of focal lengths — f_1 and f_2 placed co-axially at distance, d apart.

Therefore, the refraction matrix of the 2 lenses are —

for L_1, — $\begin{bmatrix} 1 & -P_1 \\ 0 & 1 \end{bmatrix}$

and for L_2, — $\begin{bmatrix} 1 & -P_2 \\ 0 & 1 \end{bmatrix}$

here, P_1 and P_2 are the refracting power of L_1 and L_2.

as, we know, $P = 1/f$

∴ The refraction matrices are, — $\begin{bmatrix} 1 & -1/f_1 \\ 0 & 1 \end{bmatrix}$ and $\begin{bmatrix} 1 & -1/f_2 \\ 0 & 1 \end{bmatrix}$

now, the matrix for translation through distance d in air —

$\begin{bmatrix} 1 & 0 \\ d & 1 \end{bmatrix}$

as, the refractive index, μ in air = 1.

thus, the system matrix, $S =$

$$\begin{bmatrix} 1 & -1/f_2 \\ 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 \\ d & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & -1/f_1 \\ 0 & 1 \end{bmatrix}$$

Name- Khushi Kumari Roll-no - 11
Dept. - Physics.

Assignment 1 :→ System matrix of two thin lenses separated by some distance.

Let us consider a lens of thickness of refractive index n & Radius of curvature R_1 and R_2.

Here, the system matrix (say S) is given

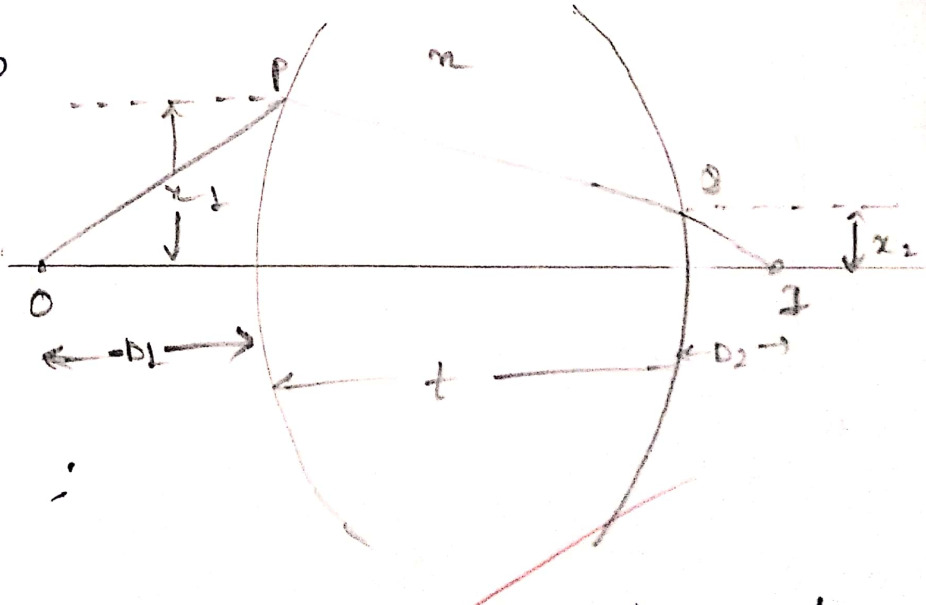
$$S = \begin{bmatrix} b & -a \\ -d & c \end{bmatrix} = \begin{bmatrix} 1 & -P_2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ t/n & 1 \end{bmatrix} \begin{bmatrix} 1 & -P_1 \\ 0 & 1 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 1 - \frac{P_2 t}{n} & -P_1 - P_2\left(1 - \frac{t}{n} P_1\right) \\ t/n & 1 - \frac{t}{n} P_1 \end{bmatrix}$$

For thin lenses, $t \to 0$
so, we have

$$S = \begin{bmatrix} 1 & -P_1 - P_2 \\ 0 & 1 \end{bmatrix}$$

$$S \Rightarrow \begin{bmatrix} 1 & -1/f \\ 0 & 1 \end{bmatrix};$$



where $f = \frac{1}{P_1 + P_2}$ is the focal length of the lens.