



Quiz 3

Solution

Honors Physics - April 2, 2004

The transport matrix for the five elements is the product of the matrix for each element taken in the reverse order of physical appearance – last drift space (x) followed by diverging lens followed by drift space (6 cm) followed by converging lens followed by drift space (24 cm):

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} 1 & x \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 1/12 & 1 \end{pmatrix} \begin{pmatrix} 1 & 6 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ -1/8 & 1 \end{pmatrix} \begin{pmatrix} 1 & 24 \\ 0 & 1 \end{pmatrix} \quad (1)$$

Multiplying all this you get:

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} \frac{1}{4} - \frac{5x}{48} & 12 - x \\ -\frac{5}{48} & -1 \end{pmatrix} \quad (2)$$

The condition for a focus is that the element B vanish so $x = 12$ cm and when this value of x is substituted into the expression for element A , the magnification, we get $A = -1$ which means the height of the image of the fishy is the same but inverted. Note also that since the matrix is unimodular the condition $B = 0$ means $A = 1/D$ which indeed is the case. And just for completeness the focal length of the system is $+48/5$ cm.