Image in an Eye

The image in the eye is formed in an index of refraction of 1.336. The rear focal length of the eye is 22.4 mm. An object is 1 m in front of the eye (in air) and has a height of 20 mm. What is the height of the image formed in the eye (on the retina)? Assume that the eye changes length to keep the image in focus.

Solution

\[ f' = 22.4 \text{mm} \quad n' = 1.336 \]

\[ f = \frac{f'}{n'} = 16.77 \text{mm} \]

\[ \phi = 0.0596/\text{mm} \]

Imaging:

\[ z = -1000 \text{mm} \quad n = 1.00 \]

\[ \frac{n'}{z'} = \frac{n}{z} + \phi = -0.001 + 0.0596 \]

\[ \frac{n'}{z'} = 0.0586/\text{mm} \quad \frac{z'}{n'} = 17.1 \text{mm} \]

\[ m = \frac{z'/n'}{z/n} = \frac{17.1 \text{mm}}{-1000 \text{mm}} = -0.0171 \]

\[ h' = mh \quad h = 20 \text{mm} \]

\[ h' = -0.341 \text{mm} \quad \text{(Inverted)} \]

Note that for this object distance, the image distance \( z' = n'(17.1 \text{mm}) = 22.8\text{mm} \).

The eye’s length must increase from 0.4 mm for this object to be in focus (from 22.4 mm to 22.8 mm).