Two Thick Lenses with a Stop

A 20 mm diameter stop is inserted between the two thick lenses (f = 100 mm; t = 25 mm) of the earlier problem. The stop is 20 mm to the right of the rear vertex of the first lens. The vertex-to-vertex separation of the two lenses is 50 mm. All units are in mm.

Determine the entrance pupil and exit pupil locations and diameters. The entrance pupil is to be located relative to the front vertex of the first lens, and the exit pupil is to be located relative to the rear vertex of the second lens.

NOTE: Only Gaussian methods may be used for this problem.
Solution:

XP: Image the stop through second lens. 

\[ z_{\text{STOP}} = -30 - d_2 = -39.84 \text{mm} \quad (\text{from } P_2) \]

\[ \frac{1}{z'_{\text{XP}}} = \frac{1}{z_{\text{STOP}}} + \frac{1}{f_2} \]

\[ z'_{\text{XP}} = -66.2 \text{mm} \quad (\text{from } P'_2) \]

\[ s'_{\text{XP}} = z'_{\text{XP}} + d'_2 = -73.8 \text{mm} \quad (\text{from } V'_2) \]

\[ m_{\text{XP}} = \frac{z'_{\text{XP}}}{z_{\text{STOP}}} = \frac{-66.2 \text{mm}}{-39.84 \text{mm}} = 1.66 \]

\[ D_{\text{XP}} = m_{\text{XP}} D_{\text{STOP}} = 33.2 \text{mm} \]

The XP is 73.8 mm to the left of the rear vertex. The XP diameter is 33.2 mm.
EP: Image stop through first lens. The stop is a real object so the light propagates from right to left to form the EP.

\[ n = n' = -1 \]

\[ z_{STOP} = 20 - d_1' = 26.90\text{mm} \quad (from \, P_1') \]

\[ \frac{-1}{z_{EP}'} = \frac{-1}{z_{STOP}} + \frac{1}{f_1} \]

\[ z_{EP}' = 36.8\text{mm} \quad (from \, P_1) \]

\[ s_{EP}' = z_{EP}' + d_i = 46.2\text{mm} \quad (from \, V_i) \]

\[ m_{EP} = \frac{z_{EP}'}{n'} = \frac{36.8\text{mm}}{26.9\text{mm}} = 1.37 \]

\[ D_{EP} = m_{EP} D_{STOP} = 27.4\text{mm} \]

The EP is 46.2 mm to the right of the front vertex. The EP diameter is 27.4 mm.