An erect object of height 3 cm is 20 cm to the left of a lens of focal length -20 cm. A second lens of focal length +50 cm is 90 cm to the right of the first lens.

(a) If the second lens were not in the system, where would the image from the first lens be?

\[ \frac{1}{u_1} + \frac{1}{p_1} = \frac{1}{f_1} \quad ; \quad \frac{1}{i_1} = \frac{1}{f_1} - \frac{1}{p_1} = \frac{1}{-20} - \frac{1}{-200} = \frac{1}{10} \quad \Rightarrow \quad i_1 = -10 \text{ cm} \]

10 cm to left of first lens

(b) How large would this image be? Is it erect or inverted?

\[ M_i = \frac{-i_1}{p_1} = -\frac{-10 \text{ cm}}{20 \text{ cm}} = \frac{1}{2} \quad \text{erect} \]

\[ \text{size} = (3 \text{ cm})(\frac{1}{2}) = \frac{3}{2} \text{ cm} \]

(c) For the whole optical system (both lenses), where is the final image relative to the second lens?

\[ \frac{1}{p_2} + \frac{1}{i_2} = \frac{1}{f_2} \quad ; \quad \frac{1}{i_2} = \frac{1}{f_2} - \frac{1}{p_2} = \frac{1}{50} - \frac{1}{100} = \frac{1}{100} \quad \Rightarrow \quad i_2 = 100 \text{ cm} \]

100 cm to the right

(d) How large would this image be? Is it erect or inverted relative to the original? Is the image real or virtual?

\[ \frac{w_2}{w_1} = \frac{-i_2}{p_2} = -\frac{100 \text{ cm}}{100 \text{ cm}} = -1 \quad \text{real} \]

\[ w_1 = w_2 = \frac{1}{2} (\frac{1}{2} \text{ cm}) = \frac{1}{2} \text{ cm} \quad \text{inverted} \]

Diagram:

- Object O₁ at -3 cm
- First lens
- Image i₁ at -10 cm
- Second lens
- Image i₂ at 100 cm
- Dimensions 20 cm, 90 cm, 50 cm