2. (30 pts.) A 0.3-cm tall object is placed at the origin on a long optical bench, such as you used in lab. A *converging* lens with a focal length of 12 cm is placed at $x = 16\,\text{cm}$ along the optical bench. Next, a *diverging* with focal length of –18 cm is placed at $x = 50\,\text{cm}$.

a. (15 pts.) Where is the final image? Is it real or virtual?

b. (15 pts.) What is the size of the final image? Is it upright or inverted?

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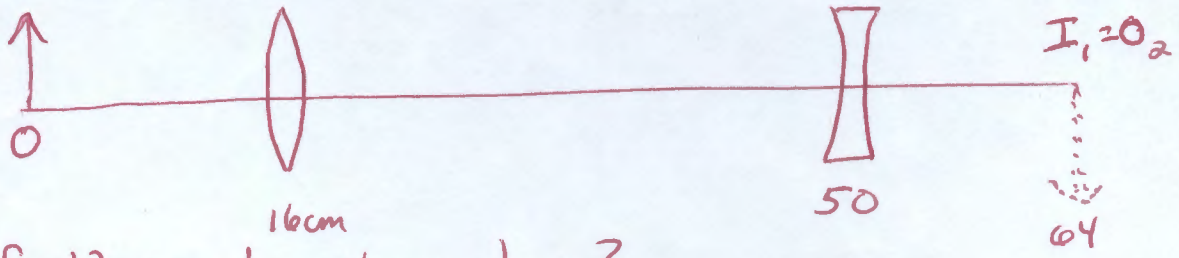

$f_1 = 12$ cm $\quad d_{o_1} = 16$ cm $\quad d_{I_1} = ?$

$$\frac{1}{f_1} = \frac{1}{d_{o_1}} + \frac{1}{d_{I_1}} \Rightarrow \frac{1}{d_{I_1}} = \frac{1}{f_1} - \frac{1}{d_{o_1}} \Rightarrow d_{I_1} = 48 \text{ cm.}$$

This means I_1 is at $16 + 48 = 64$ cm

$f_2 = -18$ cm, $\quad d_{o_2} = -14$ cm. $\quad d_{I_2} = ?$

$$\frac{1}{f_2} = \frac{1}{d_{o_2}} + \frac{1}{d_{I_2}} \Rightarrow \frac{1}{d_{I_2}} = \frac{1}{f_2} - \frac{1}{d_{o_2}} = \frac{1}{-18} - \frac{1}{-14} \Rightarrow d_{I_2} = 63$$

$\therefore$ I_2 is at $63 + 50 =$ **113 cm.**

b. (15 pts.) What is the size of the final image? Is it upright or inverted?

$$m = m_1 m_2 = \left(\frac{-d_{I_1}}{d_{o_1}}\right)\left(\frac{-d_{I_2}}{d_{o_2}}\right) = \left(\frac{-48}{16}\right)\left(\frac{-63}{-14}\right) = -13.5$$

$$h_{I_2} = m h_{o_1} = -(13.5)(0.3 \text{ cm}) = -4.05 \text{ cm.}$$ INVERTED.