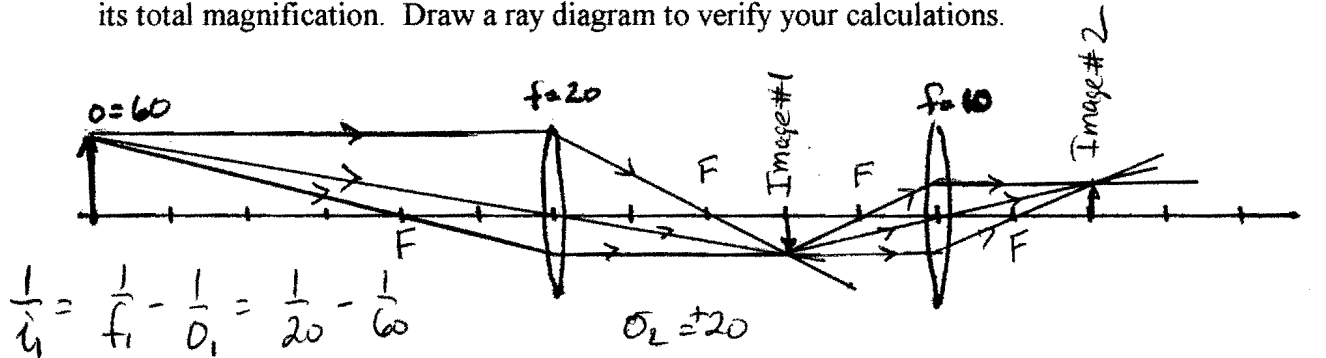1. In the three cases below, find the final image formed by the two-lens system. All lenses are converging lenses. Use algebraic methods to locate the image and determine its total magnification. Draw a ray diagram to verify your calculations.

$$\frac{1}{i_1} = \frac{1}{f_1} - \frac{1}{O_1} = \frac{1}{20} - \frac{1}{60}$$
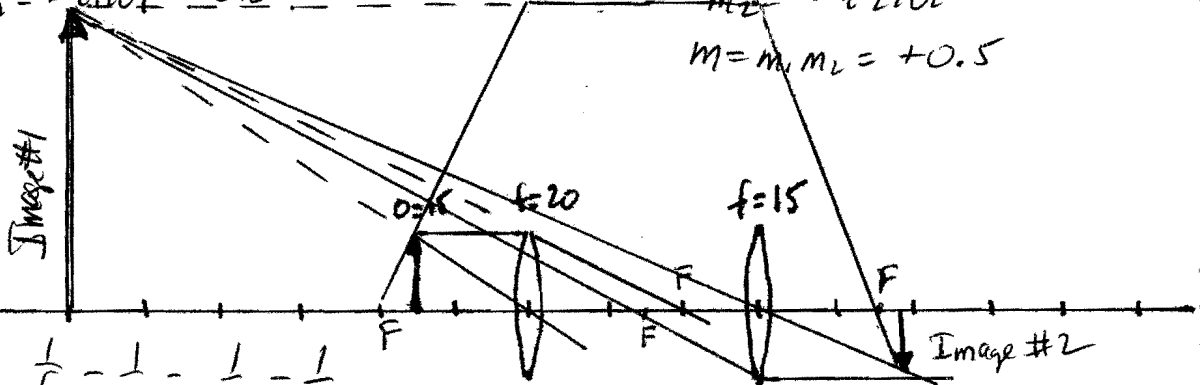
$$i_1 = +30$$

$$m_1 = -i_1/O_1 = -0.5$$

$$O_2 = +20$$

$$\frac{1}{i_2} = \frac{1}{f_1} - \frac{1}{O_2} = \frac{1}{10} - \frac{1}{20} \implies i_2 = +20$$

$$m_2 = -i_2/O_2 = -20/20 = -1$$

$$m = m_1 m_2 = +0.5$$

$$\frac{1}{i_1} = \frac{1}{f_1} - \frac{1}{O_1} = \frac{1}{20} - \frac{1}{15}$$
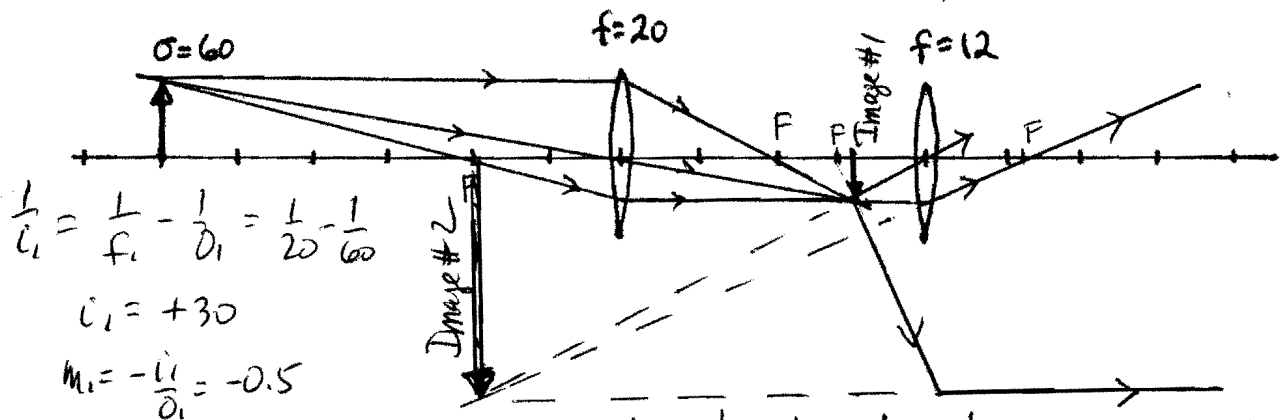
$$i_1 = -60$$

$$m_1 = -i_1/O_1 = +4.0$$

$$O_2 = 60 + 30 = 90$$

$$\frac{1}{i_2} = \frac{1}{f_1} - \frac{1}{O_2} = \frac{1}{15} - \frac{1}{90} \implies i_2 = +18$$

$$m_2 = -i_2/O_2 = -0.20$$

$$m = m_1 m_2 = -0.8$$

$$\frac{1}{i_1} = \frac{1}{f_1} - \frac{1}{O_1} = \frac{1}{20} - \frac{1}{60}$$

$$i_1 = +30$$

$$m_1 = -\frac{i_1}{O_1} = -0.5$$

$$\frac{1}{i_2} = \frac{1}{f_1} - \frac{1}{O_2} = \frac{1}{12} - \frac{1}{10} \implies i_2 = -60$$

$$m_2 = -i_2/O_2 = +6.0 \implies m = m_1 m_2 = -3.0$$