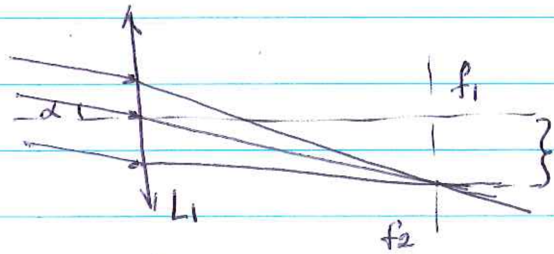
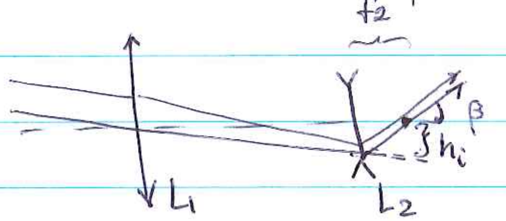
Problem 4.1

Angular magnification

First lens



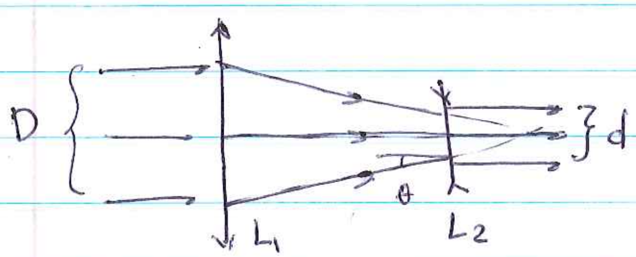
$h_i = f_1 \cdot \alpha$



$\beta \cdot |f_2| = h_i$

$\beta |f_2| = \alpha \cdot f_1$

$M_\theta = \frac{\beta}{\alpha} = \frac{f_1}{f_2}$



$\theta = D/f_1$

$d \simeq |f_2| \cdot \theta = D \, {f_2}/{|f_1|}$

For $f_o = 16\,cm$, $D = 44\,mm$, $f_e = -2\,cm$

$M_\theta = f_o/|f_e| = 8$

If the objective is the object $d_o = 14\,cm$

$$d_e = \frac{d_o \cdot f_e}{d_o - f_e} = \frac{14cm \cdot (-2cm)}{18cm} = -1.55\,cm$$

$$M = -\,{d_e}/{d_o} = \frac{1.55\,cm}{14\,cm} = 0.11$$

~~d~~ Objective apparent diameter $d' = D \cdot M = 4.89\,mm$

Problem 4.2

Magnification of the objetive lens is

$M_o = -L/f_o$, where L is the distance between the objective's focal point and the intermediate image, placed at the focus of the eye lens.

Thus, the tube length $= L + f_o + f_e$

$$L = 160\,mm - 10\,mm - 25\,m = 125\,mm$$

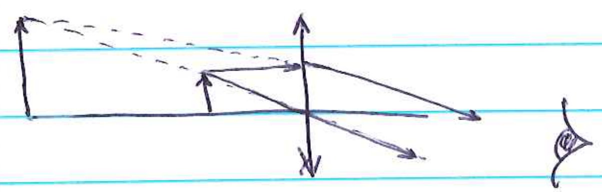
$$M_o = -\frac{125\,mm}{10\,mm} = -12.5$$

The eye piece magnification is

$$M_e = \frac{d_{near}}{f_e} = \frac{250\,mm}{25\,mm} = 10$$

Overall magnification $M = M_o M_e = -125$

4.4



$d_o = d_{near} = 25\,cm$

$d_i = -100\,cm$ (virtual image)

$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $\quad f = 33.3\,cm$

4.8

$$f_{eff} = \frac{f_1 \cdot f_2}{f_1 + f_2 - d} = \frac{f^2}{2f - 2f/3} = \frac{f^2}{4f/3} = \frac{3f}{4}$$

A1

Angle magnification $M_\theta = f_o/f_e \Rightarrow f_o = M_\theta f_e = 180\,cm$

Limit on resolution due to the eye-piece diameter

$$\Delta\theta = \frac{1.22\lambda}{D} = \frac{1.22 \cdot \lambda}{2\,cm} = \left\{ \begin{array}{c} \text{for} \\ \lambda \approx 500\,nm \\ \text{visible} \end{array} \right\} = \frac{1.22 \cdot 5 \cdot 10^{-7}\,m}{2 \cdot 10^{-2}\,m} = 3 \cdot 10^{-5}\,rad$$