Modern Optics: Homework 14

Due: 5 October 2015

1 Image production by a pair of lenses

The location of the image produced by a a pair of lenses is:

$$s_{i2} = \frac{d(s_{o1} - f_1)f_2 - f_1 f_2 s_{o1}}{d(s_{o1} - f_1) - (f_1 + f_2)s_{o1} + f_1 f_2}.$$

a) Suppose that $d = 0$. Use this expression to show that

$$\frac{1}{s_{o1}} + \frac{1}{s_{i2}} = \frac{1}{f_{\text{eff}}}$$

where the effective focal length satisfies

$$\frac{1}{f_{\text{eff}}} = \frac{1}{f_1} + \frac{1}{f_2}.$$

Now consider a telescope with an eyepiece with focal length 20 cm and an objective with focal length 10 cm. Suppose that the distance between the lenses is 30 cm.

b) In the ideal case the object is infinitely distant from the objective. Determine the location of the image produced by the eyepiece.

c) In a real case the object may be 5.0 m from the objective. Determine the location of the image produced by the eyepiece. Where is the intermediate image, produced by the objective in relation to the focal points of the two lenses?

2 Bennett, *Principles of Physical Optics*, 4.64, page 196.

3 Bennett, *Principles of Physical Optics*, 4.66, page 196. The notation $f/\#$ means $f/\# = f/D$where f is the focal length of the lens and D its diameter.