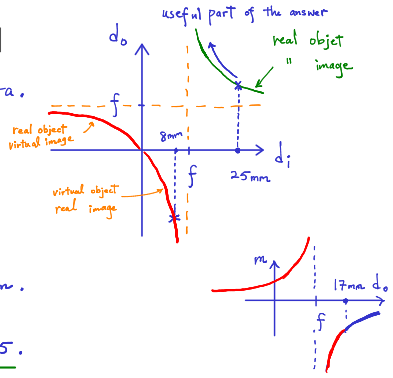
Physics Lab 206 — Mar 2016
Quiz #5 — Geometric Optics

Name:

1) Mo Ti uses a small camera to take a photo from a little coin. This camera has only one lens, with focal length +10 mm. Image distance can vary, 8 mm $< d_i <$ 25 mm.
a) Find the range for the object distance, d_o, that this camera can focus. **[2 pts]**
b) Find the maximum magnification, m. **[2 pts]**



a) The object must sit before the focal point to get real image in camera.

$\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$ or $d_o = \frac{f d_i}{d_i - f}$ or $d_i = \frac{f d_o}{d_o - f}$.

Using $d_i = 25\,mm \rightarrow d_o = 17\,mm$. $d_i = 8\,mm < f \rightarrow d_o < 0$.

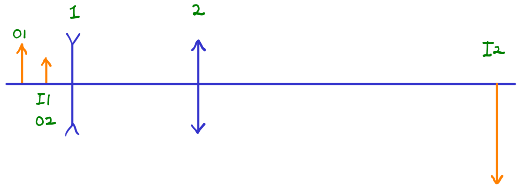
So d_o can change from 17mm to $+\infty$ and d_i from 25 mm to 10 mm.

b) $m = -\frac{d_i}{d_o} = -\frac{f}{d_o - f}$ So closer d_o to f bigger the |magnification| $\rightarrow$ $d_o = 17$ mm and $m = -1.5$.

2) Aristophanes has a concave lens with focal length −10 cm and a convex lens with focal length +20 cm. He uses concave lens as the objective (closer to the object). The concave lens sits 10 cm from the object. To make the final image sharp he needs to put the screen 60 cm from the convex lens.
a) Write an equation for the concave lens and find where its image is. **[2 pts]**
b) Write an equation for the convex lens and find where its object is. **[2 pts]**
c) What is the distance between the lenses? **[2 pts]**

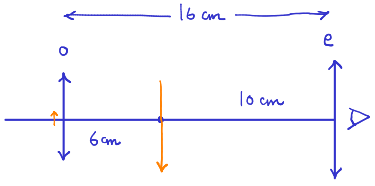
a) $\frac{1}{d_{o_1}} + \frac{1}{d_{i_1}} = \frac{1}{f_1} \rightarrow \frac{1}{10\,cm} + \frac{1}{d_{i_1}} = \frac{1}{-10\,cm} \rightarrow d_{i_1} = -5\,cm$ or $5\,cm$ before the lens.

b) $\frac{1}{d_{o_2}} + \frac{1}{d_{i_2}} = \frac{1}{f_2} \rightarrow \frac{1}{d_{o_2}} + \frac{1}{60\,cm} = \frac{1}{20\,cm} \rightarrow d_{o_2} = 30\,cm$.



c) distance $= d_{o_2} + d_{i_1} = 25\,cm$.

3) Hans Lippershey builds a microscope with two convex lenses with focal lengths f_o = 8.0 mm and f_e = 10cm. The tube length, i.e. the distance between the lenses, is d = 16 cm. The image of the objective lens is located at the focal point of the eyepiece lens (relaxed eye).
a) Find the magnification (aka linear magnification) of the objective lens. **[2 pts]**
b) Find the angular magnification of the eyepiece lens. **[1 pt]**
c) What is the total magnification? **[1 pt]**



a) $\frac{1}{d_{o_o}} + \frac{1}{d_{i_o}} = \frac{1}{f_o}$, $d_{i_o} = 6\,cm$.

$\frac{1}{d_{o_o}} + \frac{1}{6\,cm} = \frac{1}{8.0\,mm} \rightarrow d_{o_o} = 9.2\,mm$.

$\rightarrow m_o = -\frac{d_{i_o}}{d_{o_o}} = -6.5$.

b) The eyepiece works as a magnifier : $M_e = \frac{25\,cm}{f} = 2.5$.

c) $M = m_o M_e = 16$.