tutorial #9 [lenses] .quiz

1) The far point of a nearsighted person is 6.0 m from her eyes, and she wears contacts that enable her to see distant objects clearly. A tree is 18.0 m away and 2.0 m high.
a) When she looks through the contacts at the tree, what is its image distance?
b) How high is the image formed by the contacts?

a) Contacts makes an image at 6^m from objects at infinity $\rightarrow \frac{1}{\infty} + \frac{1}{-6^m} = \frac{1}{f} \rightarrow f = -6\,m$.

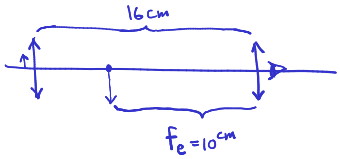
Now for tree $d_o = 18.0\,m \rightarrow \frac{1}{18\,m} + \frac{1}{d_i} = \frac{1}{f} = \frac{1}{-6\,m} \rightarrow d_i = -4.5\,m$ closer than the far point so eye can focus

b) $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o} = \frac{4.5\,m}{18\,m} = 0.25 \rightarrow h_i = 0.25\,h_o = 0.5\,m$

2) Hans Lippershey builds a microscope with two convex lenses with focal lengths $f_o = 8.0$ mm and $f_e = 10$ cm. 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 linear magnification of the objective lens.
b) Find the angular magnification of the eyepiece lens.
c) What is the total magnification?

$d_i = \infty$ for relaxed eye

eyepiece lens → magnifier, $M = \frac{N}{d_o} = \left(\frac{1}{f} - \frac{1}{d_i}\right) N = \frac{N}{f}$



a) $f_o = 8.0^{mm}$, $d_i^{(obj.)} = 16^{cm} - 10^{cm} = 6^{cm}$, $\frac{1}{d_o^{(obj.)}} + \frac{1}{d_i^{(obj.)}} = \frac{1}{f_o}$

So $d_o^{(obj.)} = 0.9^{cm} \rightarrow m = -\frac{6\,cm}{0.9\,cm} = -7$

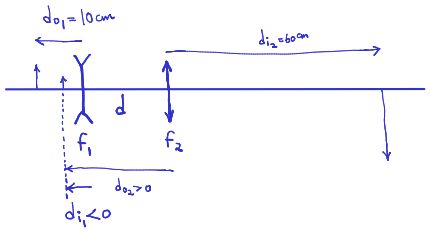
b) $M = \frac{25\,cm}{f_e} = 2.5$

c) $M_{tot} = 7 \times 2.5 = 17.5$.

3) Aristophanes has a concave lens with focal length $f_1 = -10$ cm and a convex lens with focal length $f_2 = 20$ cm. He uses concave lens as the objective. The distance between the object and the concave lens is $d_{o1} = 10$ cm and the distance between the image (image for the convex lens) and the convex lens is $d_{i2} = 60$ cm.
a) Write an equation for the concave lens and find the distance of its image from itself.
b) Write an equation for the convex lens and find the distance of its object from itself.
c) What is the distance between the two lenses?

a) $\frac{1}{d_{i_1}} + \frac{1}{d_{o_1}} = \frac{1}{f_1} \rightarrow d_{i_1} = \frac{f_1 d_{o_1}}{d_{o_1} - f} = -5\,cm$.

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



c) $d = d_{i_1} + d_{o_2} = -5\,cm + 30\,cm = 25\,cm$.

the image for the lens 1 is the object for the lens 2.