OPTI 201R Midterm 1 October 13, 2016

Answer all questions. Show your work. Partial credit will be given. Don't spend too much time on any one problem. Use separate sheets of paper and don't cram your work into the spaces below. Problems are worth 10 points each.

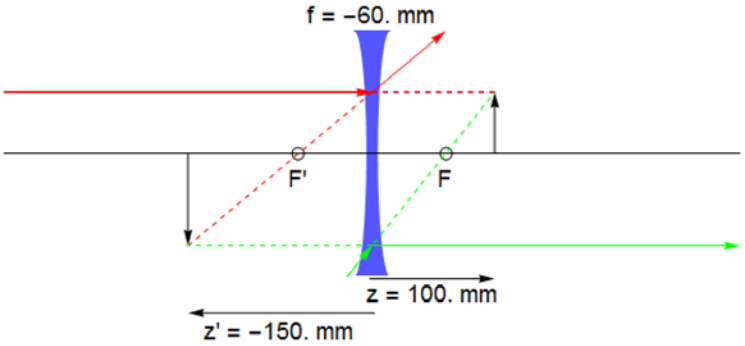
For problems 1-8, provide the requested values and draw a sketch of the system. The basic thin lens in air equations are

$$\frac{1}{z'} - \frac{1}{z} = \frac{1}{f} \quad and \quad m = \frac{z'}{z}$$

1. Given a focal length f = −60. mm and a magnification m = −1.5, what is the object distance z and the image distance z'?

The object distance is given by $z = f\left(\frac{1}{m} - 1\right) = 100.$ mm.

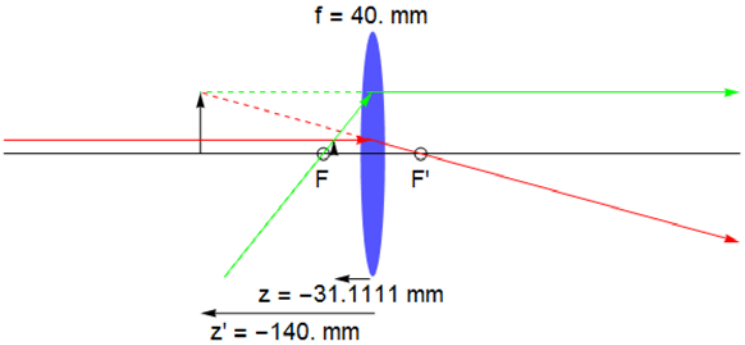
The image distance is given by $z' = mz = -150.$ mm.



2. The image distance is 140. mm to the left of the lens and the lens focal length f = 40. mm, what is the object distance z and the magnification m?

The object distance is given by $z = \frac{1}{\frac{1}{z'} - \frac{1}{f}} = -31.1111$ mm.

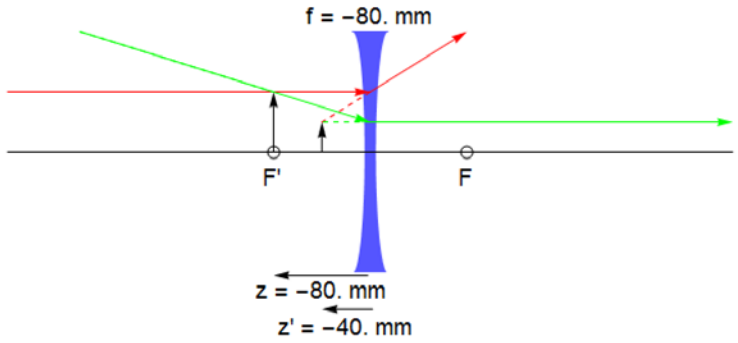
The magnification is given by $m = \frac{z'}{z} = 4.5$



3. The image distance is 40. mm to the left of the lens and the magnification m = 0.5, what is the focal length f and the object distance z?

The focal length is given by $f = \frac{z'}{1-m} = -80.\ \text{mm}$.

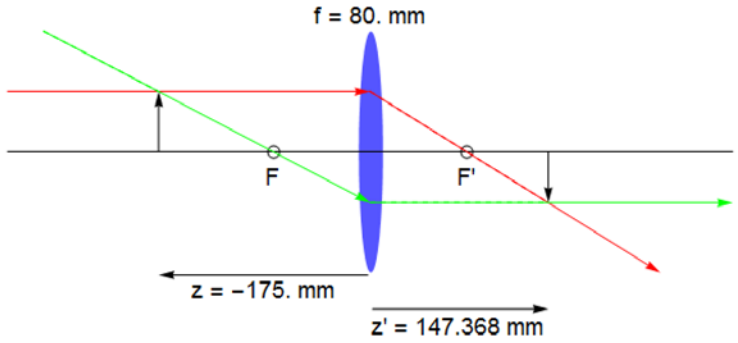
The object distance is given by $z = \frac{z'}{m} = -80.\ \text{mm}$.



4. The object distance is 175. mm to the left of the lens and lens has a focal length f = 80. mm, what is the image distance z'? and the magnification m?

The image distance is given by $z' = \frac{1}{\frac{1}{z}+\frac{1}{f}} = 147.368\ \text{mm}$.

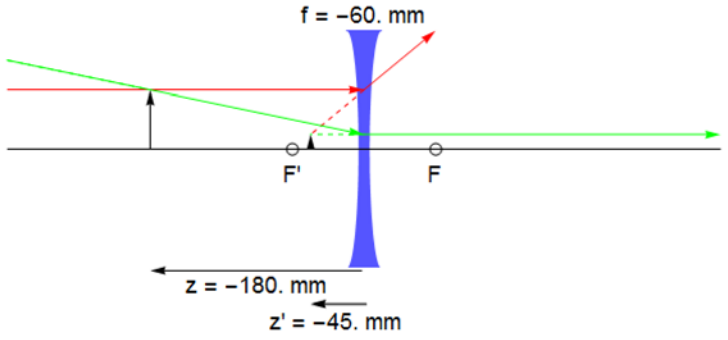
The magnification is given by $m = \frac{z'}{z} = -0.842105$



5. Given an object distance z = −180. mm and an image distance z' = −45. mm, what is the focal length f and the magnification m?

The focal length is given by $f = \frac{1}{\frac{1}{z'}-\frac{1}{z}} = -60.\ \text{mm}$.

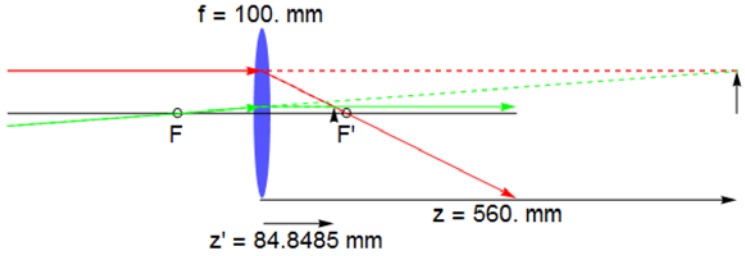
The magnification is given by $m = \frac{z'}{z} = 0.25$



6. The object distance is 560. mm to the right of the lens and lens has a focal length f = 100. mm, what is the image distance z'? and the magnification m?

The image distance is given by $z' = \frac{1}{\frac{1}{z}+\frac{1}{f}} = 84.8485$ mm.

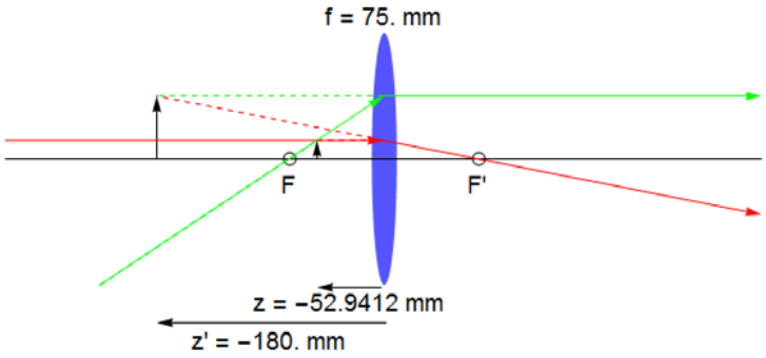
The magnification is given by $m = \frac{z'}{z} = 0.151515$



7. The image distance is 180. mm to the left of the lens and the lens focal length f = 75. mm, what is the object distance z and the magnification m?

The object distance is given by $z = \frac{1}{\frac{1}{z'}-\frac{1}{f}} = -52.9412$ mm.

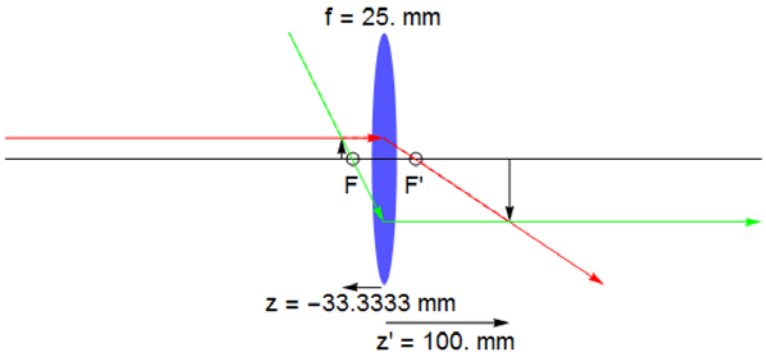
The magnification is given by $m = \frac{z'}{z} = 3.4$



8. The image distance is 100. mm to the right of the lens and the magnification m = −3., what is the focal length f and the object distance z?

The focal length is given by $f = \frac{z'}{1-m} = 25.$ mm.

The object distance is given by $z = \frac{z'}{m} = -33.3333$ mm.



9. N-LaF2 is a type of glass with refractive index of 1.744.

a) If a ray in air strikes the surface of the N-LaF2 at an angle $\theta = 25°$, what is the angle θ' of the refracted ray inside the material?

From Snell's law

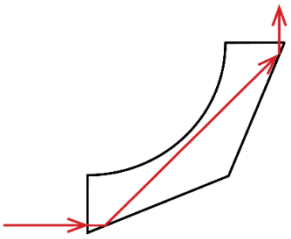
$$sin25° = 1.744 sin\theta'$$
$$\theta' = 14.02°$$

b) If a block of N-LaF2 is in air, what is the critical angle for a ray traveling inside the material?

The critical angle is given by

$$\theta_c = sin^{-1}\left(\frac{1}{1.744}\right) = 34.98°$$

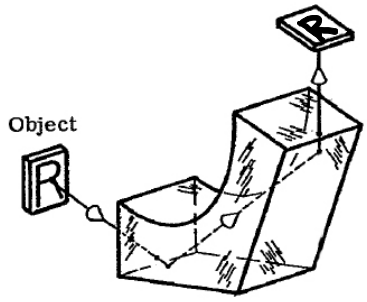
10. The Figure below shows a Wollaston prism with a ray traced through it.



a) Is parity conserved for this prism?

Yes, there are two (even number) reflections.

b) Draw the orientation of the letter R emerging from the prism on the figure below



c) Circle the correct tunnel diagram for the Wollaston prism.