PHYS2063 Wave Physics Fall 2017 HW #10 Due 17 Nov 2017

(1) The point of this problem is to derive the lens equation

$$\frac{1}{i} + \frac{1}{o} = \frac{1}{f}$$

by reproducing the derivation we went through in class, and then extending it to the other two cases shown in the figure at the following link...

https://phys.cst.temple.edu/~napolj/PHYS2063/HRK5eCh40Fig24.jpg

...which shows object-to-image ray tracing of (a) an object behind the focal point of a convex lens, the case we worked in class; (b) an object in front of the focal point of a convex lens; and (c) an object behind the focal point of a concave lens.

(a) For case (a), reproduce the derivation we went through in class, where o, i, and f are the (positive) distances from the lens to the object, image, and focal point, respectively. Do this by making use of similar triangles, and recognizing that the ray distances from the optical axis at the lens are the heights of the object and image, for the rays that do not pass through the center. Show that the magnification $m = -i/o$ gives the correct magnitude and sign for the ratio of the height of the image to that of the object.

(b) Repeat for case (b), and show that the same equation holds, but with $i < 0$ because it is on the left ("virtual") side of the lens.

(c) Now repeat for case (c), the concave lens. Show that the sign conventions are still correct, but with $f < 0$ for a concave lens.

(d) Finally, carry through the following calculation. Light is incident in the rightward direction on a thin diverging (concave) lens having a focal length of 30 cm. An object is 20 cm to the left of the lens. Where is the image formed? What is the magnification $m = -i/o$? Is the image inverted or upright?

...AND...

(2) Show that the distance between a real object and its real image formed by a thin converging lens is always greater than or equal to four times the focal length of the lens.