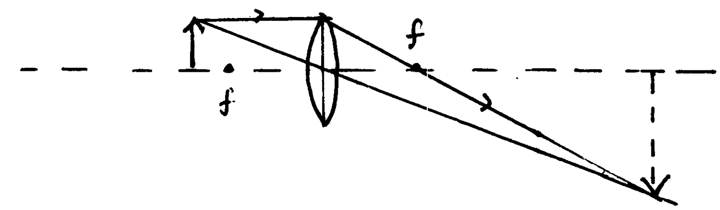
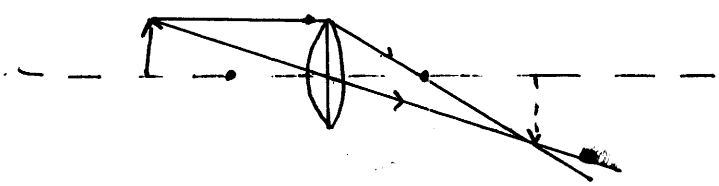
Lab #2 Predictions and Warmups

Problem #1 : Prediction

Using a convex lens to form a magnified real image: the greatest magnification is obtained when the lens is slightly farther from the object than the focal length. This minimizes $\frac{1}{f} - \frac{1}{s_o}$ thereby maximizing s_i.

Warmups

1. 

2. 

The image moves closer to the lens.

Note: To make this drawing I kept the lens position the same and moved the object so that comparing how close the image is to the lens is easier. In a microscope you keep the object in the same place and move the lens. That's the same drawing just shifted to the right.

3. If f is constant and s_o increases:

$\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$ indicates s_i must decrease to keep RHS constant as LHS is constant

In #2 we also see s_i decreases.

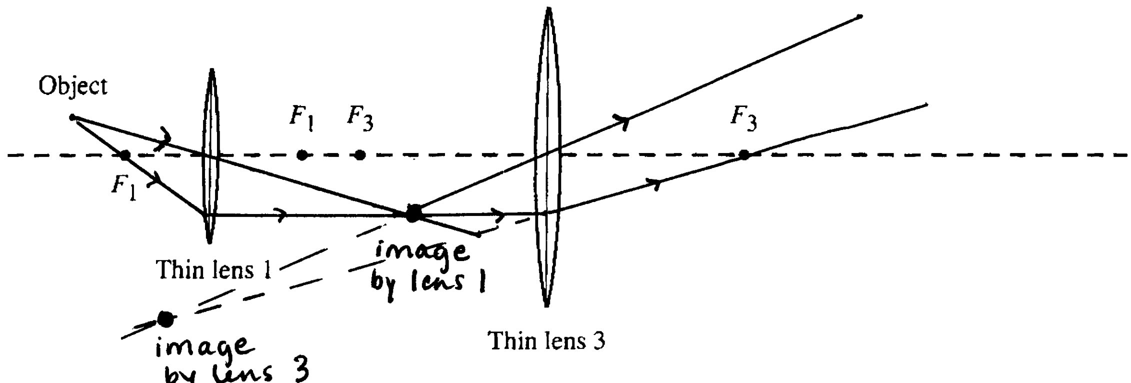
4. We can rearrange the lens equation to read

$\frac{1}{s_o} = -\frac{1}{s_i} + \frac{1}{f}$ Comparing to $y = mx + b$, this shows that the graph of $1/s_o$ vs $1/s_i$ should be a line with slope $= -1$, intercept $= 1/f$

So, graph this and the intercept gives $1/f$.

From Lab 2, Problem 2 Warmup "The Compound Microscope" (modified from *Tutorials in Introductory Physics*, McDermott *et al*, Pearson)

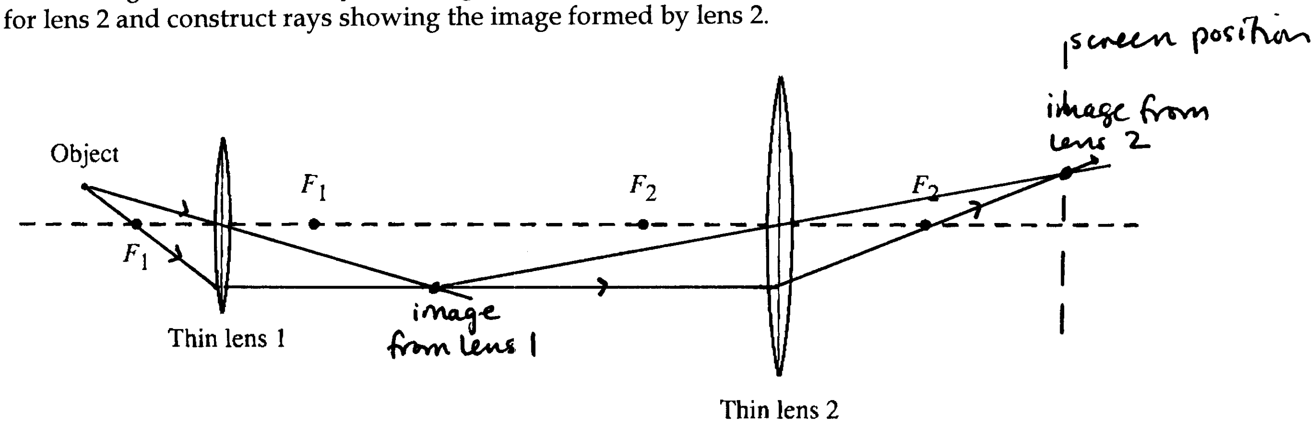
1. The diagram below shows an arrangement of a small object and two thin convex lenses analogous to that used in a typical compound microscope (though not to scale). On the diagram, construct rays showing the image formed by lens 1, then use that image as the object for lens 3 and construct rays showing the image formed by lens 3. (There is no lens 2 in this diagram.)



2. Think of lens 1 as the objective lens and lens 3 as the eyepiece lens of a microscope. Does the eyepiece lens form an image that could be projected on a screen? If so, where should the screen be placed? If not, is it possible to adjust (reposition) lens 3 so that its image could be projected on a screen?

The image produced by lens 3 is virtual so it cannot be viewed on a screen. Moving lens 3 to the right so that F_3 is to the right of ~~the~~ the image formed by lens 1 would allow lens 3 to form a real image, which could be projected on a screen.

3. The diagram below shows another possible arrangement of a small object and two thin convex lenses. On the diagram, construct rays showing the image formed by lens 1, then use that image as the object for lens 2 and construct rays showing the image formed by lens 2.



4. Think of lens 1 as the objective lens and lens 2 as the eyepiece lens of a microscope. Does the eyepiece lens form an image that could be projected on a screen? If so, where should the screen be placed? If not, is it possible to adjust (reposition) lens 2 so that its image could be projected on a screen?

This image could be cast on a screen if the screen is placed as shown, because it is a real image.

5. (Not required for homework, just for lab): To keep the microscope compact, we want the shortest focal length lens, as reducing the focal length reduces s_o and thus s_i required for a given magnification.

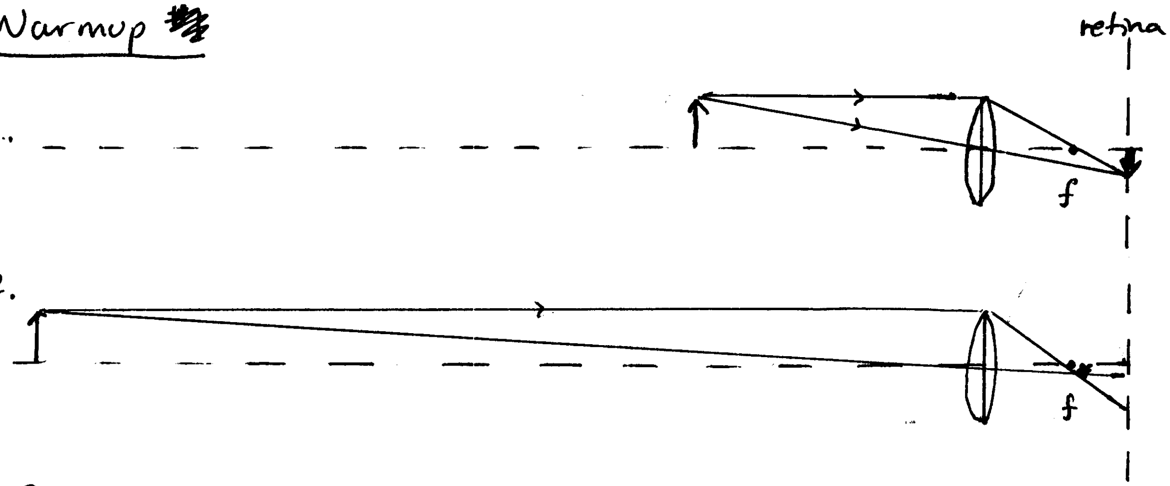
Problem #3

Prediction: The corrective lens should be diverging, because the image formed by the corrective lens needs to be closer to the lens than the object. A diverging lens accomplishes this, while a converging lens forming a virtual image puts the image farther away than the object. (If a converging lens forms a <u>real</u> image, that image is on the opposite side of the lens from the object and cannot be viewed by the wearer!)

Warmup

1.

2.



The image moves closer to the focal plane, away from the retina. A corrective lens needs to be diverging for the reason explained above.