Physics 4L, Spring 2010 — Problem set 2
Due Tuesday 2 February in class

Problems from Wolfson:
Chapter 31 "For Thought and Discussion" question 14
Chapter 31 problem 24
Chapter 31 problem 26
Chapter 31 problem 52. In your solution, include a ray diagram with the object and image distances and focal length shown reasonably close to scale.
Chapter 31 problem 53
Chapter 31 problem 54

Additional problems:
1. (a) Catherine Crouch's contact lens prescription is -3.00 diopters. Is she nearsighted or farsighted? As part of your answer, explain the meaning of the negative sign in her prescription.
(b) When she is wearing them, her contact lenses create images of distant objects at the farthest distance where she can see clearly without contact lenses. If she is *not* wearing her contact lenses, what is the maximum distance at which she can read a computer screen clearly?
(By the way: those of you with the same vision shortcomings can try this – from your prescription you should be able to calculate the maximum distance at which you can read a book or a computer screen pretty accurately. If you're interested, we can discuss the reasons for small discrepancies ...)

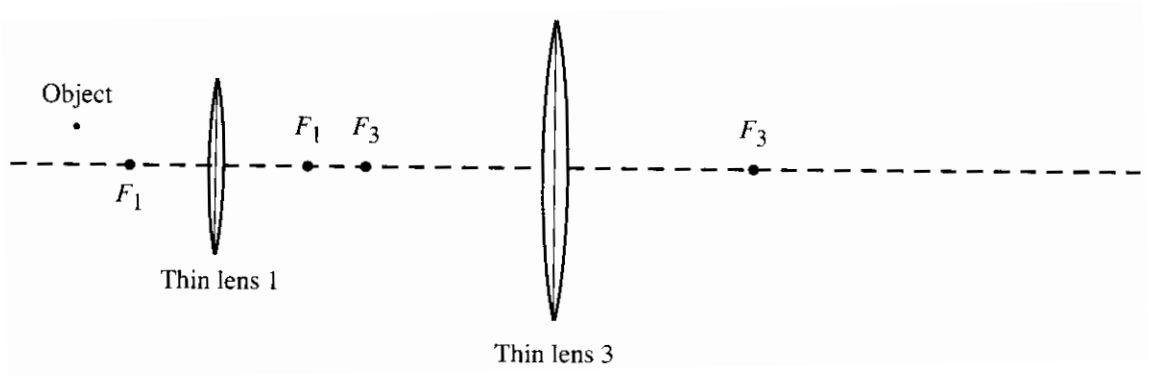
Also turn in part of Lab 2 warmup assignment (on back of this sheet):
The Lab 2 warmup assignment is longer than usual, so turn the part on the back of this sheet to be graded so that you get some problem set credit for it. Make a copy of your work to bring to lab. Feel free to get help with the prelab assignment just as with the rest of the problem set.

Self-test problem appears on the last page.

For extra credit: Show algebraically (with a calculation, not with rays) that a diverging lens can only form a reduced image.

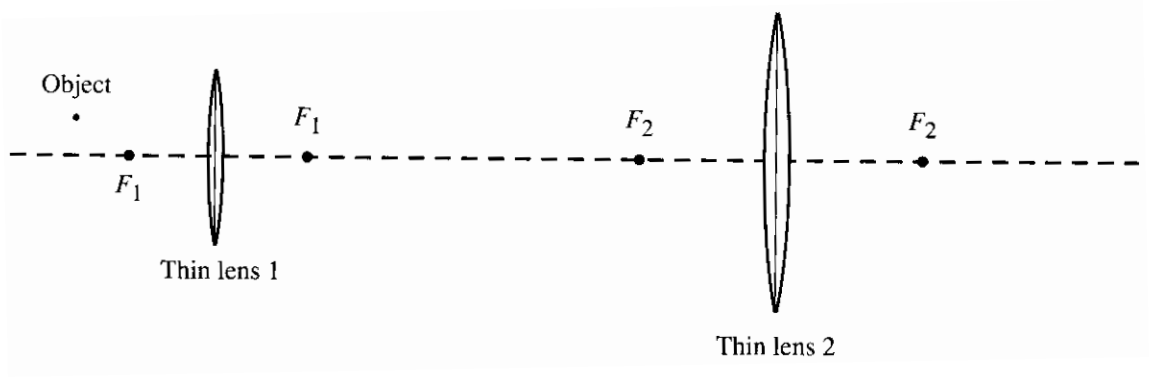
From Lab 2, Problem 2 Warmup "The Compound Microscope" (modified from *Tutorials in Introductory Physics*, McDermott *et al*, Pearson)

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?

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?

Self-test problem, PS 2 Name: _____

You may spend up to 25 minutes on this problem. Do your work on this sheet in the space provided and turn it in separately. Do not work with others or refer to the textbook, though you may consult the equation sheet posted online. Your score on this problem will not be included in your homework grade; it is solely for feedback to you. (However, you *will* receive credit for one homework problem for completing it.)

(a) If Amy Bug (former Physics 3 professor) holds a physics textbook 30 cm in front of her glasses (prescription +2.25 diopters), where is the image of the page created by her glasses? Is the image virtual or real? Upright or inverted?

(b) Is Amy Bug nearsighted or farsighted? Explain briefly why.

(c) The distance from Amy Bug's retina to the lens of her eye is 23 mm, and the distance from the lens of her eye to her glasses is 2.0 cm. What is the focal length of her eye's lens, if the image is in focus? (You may calculate either the focal length in air or the focal length in the eye, as long as you clearly specify which you calculated. Be sure to account for the effect of the index of refraction of the contents of the eye ($n_{eye} = 1.34$).)
Note: You do not need to include a ray diagram in your solution, but do provide a diagram showing the locations of the glasses, the image formed by the glasses, the eye lens, and the retina, and label the diagram with the distances you used in solving this problem.