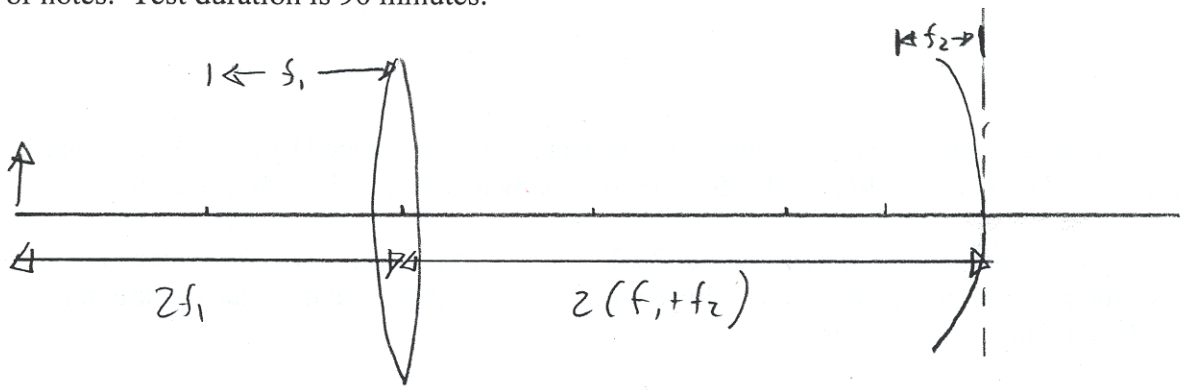
Physics 7C, Fall 2003, Section 1
Instructor: Prof. Adrian Lee

First Midterm Examination, Monday Sept 29

Please do work in your bluebooks. You may use one double-sided 3.5" x 5" index card of notes. Test duration is 90 minutes.



1) An upright object is placed a distance in front of a converging lens equal to twice the focal length f1 of the lens. On the other side of the lens is a converging mirror of focal length f2 separated from the lens by distance 2(f1 + f2) (40 points total)

a) Make a ray diagram showing where the image is for a person looking from the object side of the lens. (10 points)

b) What is the distance from the lens to the image? (15 points)

c) What is the magnification (including orientation) of the image in terms of the object height h? (10 points)

d) Is it a real or virtual image? (5 points)

2) For the human eye, the near-point distance is the closest distance from the eye that the eye can focus on. Similarly, the far-point distance is the furthest point the eye can focus on. A nearsighted person has a far-point distance of 15 cm and a near-point distance of 10 cm. In all parts, disregard the eye-to-lens distance. (40 points total)

a) Give the sign and magnitude of the focal length of the lens needed to correct this far vision. Note that after passing through this lens, light from infinity should appear to come from 15 cm. Is the lens convex or concave? A ray drawing may help your thinking. (20 points)

b) With this lens in place, what is the distance to this person's near point? (20 points)

3) Consider two-slit interference where the slits are identical, spaced by a distance D and illuminated by coherent light. The distance from slits to screen is L. (40 points total)

a) If you move the slits further apart to 2 x D how do you have to move the screen to have the position of the peaks and valleys remain unchanged? Assume that you are in the small angle limit. (12 points)

b) Calculate the intensity as a function of angle either algebraically or by the phasor method in terms of I_0 the intensity at the center of the pattern. The following relation may be useful. (16 points)

$$Sin(A) + Sin(B) = 2Sin\left(\frac{A+B}{2}\right)Cos\left(\frac{A-B}{2}\right)$$

c) If a slab of clear dielectric with thickness t and index n is put over one slit, how does the intensity pattern change? Is there a relation between n, t, and λ to have no change of the pattern? (12 points)

4) It is possible to levitate a spherical glass bead in a vertically upward directed laser beam. If the bead mass m is 2×10^{-6} gm, and its density r = 0.3 gm/cm^3, what power, P, laser beam will support the bead? Assume the laser beam diameter d = 2 mm and that the bead reflects the laser light. For simplicity, assume the light is all reflected directly downwards. (20 points total)