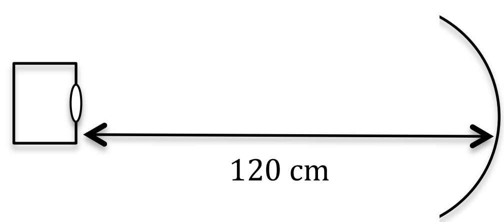
HW #13 Due at the beginning of class 4/29/11

This week we will finish up Ch. 24 and then move into Ch. 27. Unfortunately we do not have time to really do Ch. 26 on relativity, but we will talk about it on the last day of class. We will only touch briefly on Ch. 24 Sections 8 and 10, and will not touch sections 9, 11, or 12 at all.

Problems 1-3 and 7-9 should serve as an excellent review for the quiz on Friday.

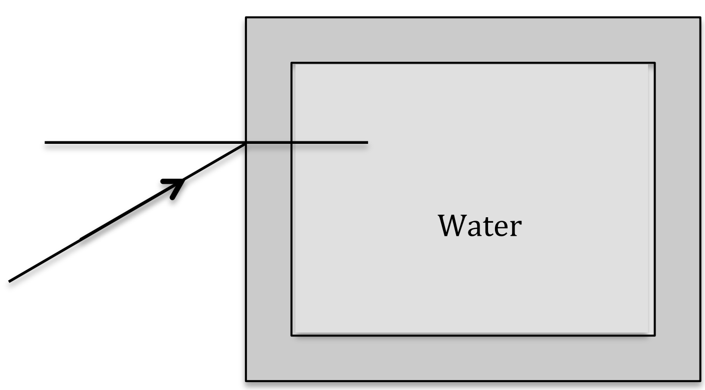
Part I

1) A camera with a 50 mm focal length lens is used to take a picture of the image of itself formed by a concave mirror with a radius of curvature of 80 cm (see photo on Physerver). The distance from the camera lens to the mirror is 120 cm. In order for the picture to be in focus, what must be the distance between the camera lens and the film? Note: This is a multistep problem that uses what you know about image formation for mirrors and lenses.



2) Construct a ray diagram for an object placed 30 cm from a diverging lens with a focal length of -15 cm. Determine the image distance and the size of the image relative to the object.

3) The figure below shows a ray of light entering a glass (n=1.52) aquarium filled with water. You are looking at the aquarium from above. The thickness of the glass is exaggerated. The light enters the glass at an angle of incidence of 35º. Show the path the light takes through the aquarium. Label appropriate angles and show the mathematics you used.



4) Ch.24 P1

5) Ch.24 P5

6) For this problem you should use the circular wave transparencies passed out in class on Friday along with a ruler. Position the transparencies so that the sources are separated by 1.0 cm. At a distance of 5.0 cm from the sources (measured along the perpendicular bisector to the line joining the two sources) measure the distance from the central maximum to the first order maximum on each side. Use the average of your two measurements to determine λ. Measure the wavelength directly by measuring from one crest to another crest that is 10 wavelengths away (and dividing by 10). Why is it better to measure 10 wavelengths instead of just one? Be aware that the agreement between your two wavelength values will not be perfect because d is not much less than L, as we assumed when deriving the formula for constructive interference. You should be within 20% though.

Part II

7) In lab last week you used a lens with a 10 cm focal length first as a magnifying glass and then as an eyepiece in a microscope and a telescope. In each case, you placed the lens 6 cm from the "object". When used with the microscope and the telescope the "object" was the image produced by the objective.
a) Calculate the image distance and the linear magnification ($m = -d_i/d_o$).
b) Determine the angular magnification assuming a near point of 25 cm and assuming that the lens is 6 cm from the "object". To do this you can assume that the object has a certain height, for example 0.1mm, or you could just call the height h_o. This problem is just like you did last week for the entomologist problem.
c) Calculate the magnification of the lens if the "object" is placed at 10 cm. Hint: Where is the image if the object is at 10 cm? In this case you can use one of the formulas in the textbook.
d) Calculate the magnification of the lens if the lens is positioned so that the image is at the near point. Again, in this case you can use the appropriate formula in the textbook.

8) Ch.25 P43 Assume a normal eye with a near point of 25 cm.

9) An aged, farsighted physicist has lost so much flexibility in the lenses in his eyes that he cannot even see stars clearly. In other words, his near point is past infinity, which is pretty far away.
a) Relative to the retina, where does the image form when he looks at a star?
b) When wearing contact lenses with a power of +1.5, his near point is about 3 m. In other words, with these contacts he can focus on anything between infinity and 3 m, but not on things closer than 3 m. Suppose that to see things closer, he wears reading glasses in addition to his contacts. What strength reading glasses would he need to make his near point 25 cm? Assume the glasses sit 2 cm in front of his eyes.

10) Ch.24 P20

11) Light from a 589 nm laser is shone through two slits that are 0.25 mm apart. The pattern is viewed on a screen 5.5 m away. It is noticed that the 4th order maximum is "missing" because it coincides with the first diffraction minimum. What is the width of the slits in mm? Note: You can do this problem without knowing λ, since the missing maximum tells you what the slit width is relative to the slit separation, and is independent of λ.

12) Violet light with a wavelength of 420 nm is sent through a diffraction grating that has 6100 slits/cm. Find the angle of the first order, second order, and third order maxima. Repeat for red light with a wavelength of 650 nm. Is there a third order maximum for red? Explain. What surprising thing do you notice about the angle for the 3rd order violet compared to the 2nd order red?