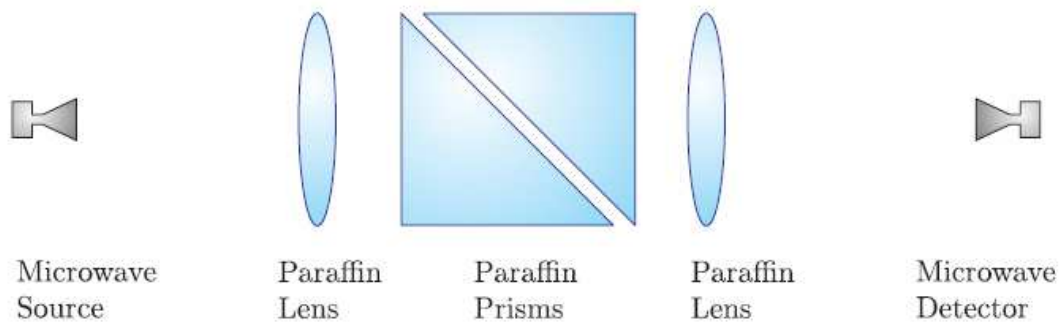


HW6 Ch 5: 7, 12, 36, 32, 45, 47 Note: on 45, 47 you can print out copies of the figures to make ray drawings on, from the pdfs on the website.

Problem 6A (Walk-in Lab: Extreme south of 4th floor) See a short video of the lab: <http://optics.byu.edu/video/evanwave.mov> . Measure the intensity of transmitted microwaves ($\lambda_{\text{vac}} = 3 \text{ cm}$) in frustrated total internal reflection by varying the gap separating two paraffin wax prisms ($n = 1.5$). The 45° right-angle prisms are arranged with the geometry shown below. Plot the theoretical intensity $I(d)$ from above and experimental intensity transmitted as a function of separation d (**normal** to gap surface, not the horizontal distance). In both plots normalize the intensity so $I(0) = 1$, and plot them in linear-linear plots and $\log(I)$ vs linear(d) plots.



HW7 Ch 5: 58, 60, 61, 74, 87, 88

HW8

Lab in optics lab room. Do these with **one or two lab partners**.

8A. Lab version of problem 5.31. Choose a converging lens with what you guess to be a focal length of a few centimeters. First estimate f by imaging the overhead light (more than 1m away) onto a paper on the table. Lens-paper distance is close to f . Put the lighted object box on the optical rail, and a screen more than $4f$ away (but it's best if it's not a lot more than that). Move the lens until you get an image. Measure s_i and s_o . Move the lens only and find another point that will make an image on the screen. d is distance the lens moves. Find f as in problem 5.31. Make a drawing of your setup and the distances and compare the final f with your estimate.

8B. Magnifier. Use the converging lens in 8A. Hold it right up to your face, and look through it with one eye to magnify a ruler. Move the object until you see an image. Now at the same time look with the other eye at another ruler which is at your nearpoint. Have a partner help you hold the two rulers, one at your nearpoint, the other close to f of the lens near your eye so that the ruler is magnified and in focus (see figure 5.91). Or you could use a holder on the table. Find the angular magnification by how big the marks are magnified compared to the other ruler. Record all of your numbers, and include a diagram of your setup labeled with distances. Compare with eq 5.77.

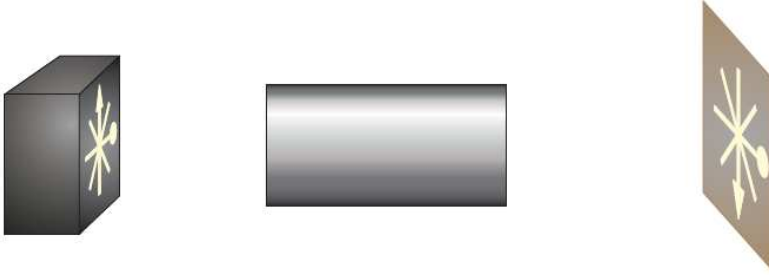
8C. Microscope. See Fig 5.99. Chose two short focal length lenses and make a simple telescope. Put the lighted object pretty close to the focal length f_1 of the first lens so that you get an image on a screen about 15 cm away (close to the 16 cm taken as standard in the text). Take out the screen and put your second lens a distance f_2 beyond the image and put your eye up close to see the magnified virtual image of the source at infinity. Focus by moving lens 2. Record all of your numbers, and include a diagram of your setup labeled with distances. Write down the magnification you expect from eq 5.81 and see if it makes sense with what you saw.

8D. Telescope. See Fig 5.106. Open the door so you can see at least across the room (or if 2nd door is open to the end of the hallway). Leave your eyepiece in the rail, and put a long focal length lens the correct distance away to see as far as you can. Record all of your numbers, and include a diagram of your setup labeled with distances. Write down the magnification you expect from eq 5.83 and see if it makes sense with what you saw. Now twist the long focal length mirror a little so it's not perpendicular to the rail, and describe the coma aberration you see.

8E. on next page

8E. See video at <http://optics.byu.edu/video/complens.mov>

Deduce the positions of the principal planes and the effective focal length of a compound lens system. Reference the positions of the principal planes to the outside ends of the metal hardware that encloses the lens assembly.



Make three measurements of object and image distances and write three equations to solve for the ABCD matrix and principal planes of this lens system. (The ABCD matrix itself does not include image and object distances). The easiest way to do this is to realize that the measurements obey an imaging equation, as long as distances are from the (unknown) principal planes: $\frac{1}{d_1 - p_1} + \frac{1}{d_2 - p_2} = \frac{1}{f_{eff}}$. Solve for f and the p 's then find ABCD from them and one more condition that is always true for every ABCD like this.

HW9 Ch 6:13 Ch7:4, 6, 9, 11

9A. Show that the group velocity can be written in the following forms:

1. $v_g = v_p - \lambda \frac{dv_p}{d\lambda}$. Hint: $\omega = kv_p$ is a good starting point.

2. $v_g = v_p + \frac{c\lambda}{n^2} \frac{dn}{d\lambda}$

3. $v_g = \frac{c}{n + \omega(dn/d\omega)}$. Hint: $\frac{d\omega}{dk} = \frac{1}{\frac{dk}{d\omega}}$

HW10 Ch 8:1(don't turn in), **3** (write in terms of Jones vectors), **16, 32, 46** (don't turn in)

Problem 10.A See the setup in Fig 8.45. Use Jones matrices. Choose the fast axis to be **vertical** in B and C.

1. Make a JM that combines A and B. Start with a light state that is **vertically** polarized left of A. Confirm that it makes circular light after B, and determine which kind
2. Now confirm the italicized statements in the paragraphs below the figure, that one form of circular light entering the A&B element from the B side will be transmitted, and the other form will be absorbed.
3. Form a matrix for C&D and show that A&B&C&D together gives you the final state shown to the right of D. Determine the final intensity of the light after D as a percentage of the initial state intensity.
4. Rotate C so that its fast axis is horizontal. What is the final state after D? Explain the result.
5. Rotate C so that its fast axis is at 45° above the +x (horizontal) axis. What is the final intensity as a percentage of the initial state intensity?

Problem 10.B Confirm from Fresnel's equations that the correct angle in Fig 8.41 is 54.6° to make a total internal reflection circular polarizer prism. You need to find both r_s and r_p for the reflection to show the *difference* in phase between the two is what is needed.

Problem 10.C A $\frac{1}{2}$ wave plate with fast axis at an angle θ vs the x axis is placed between two crossed polarizers at 0 and 90° vs the x axis. What is the intensity of unpolarized light as a function of θ ? To simulate unpolarized light do it for both H then V polarized input states and take the average. Explain the result in what you know about $\frac{1}{2}$ waveplates and polarizers.

HW11 Ch 9:3,6,12,13,14.

Notes:

#3 Easiest to do it with complex plane waves, and have each beam tilted $\theta/2$ from the screen normal. For simplicity he is dropping constants like n, c, ϵ in front of E_o^2 from the definition of the intensity, as discussed in the text).

#12,13 Both of these cause a phase shift of the second slit emission vs the first, which shifts the pattern. Go through the derivation of constructive interference in each case, keeping track of the total phase difference, rather than looking for something already done in the book.