HW #12 Due Friday April 22, at the beginning of class.

Reading: On Monday we will finish up Chapter 23 and cover the first 3 sections of Chapter 25 about lenses and vision. In lab you will study lenses including the telescope and microscope, which are covered in Chapter 25-4 and 25-5. After that we will start Chapter 24 on the wave nature of light. We have already talked in class about section 4 in Chapter 24, so there are a couple of problems in this HW pertaining to that section.

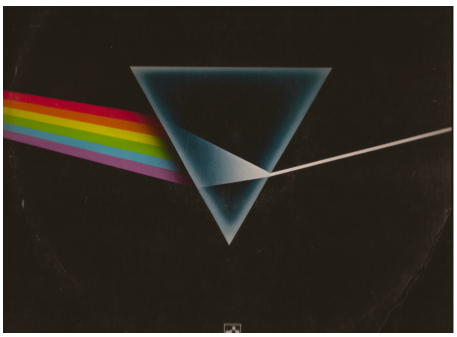
Part I

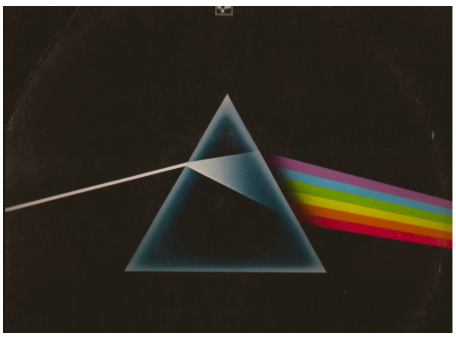
1) Ch. 23 P31 Use $n_{water} = 1.33$.

2) Ch. 23 P73

3) Ch. 24 P16 Refer to the graph on p672 to estimate the index of refraction at each wavelength.

4) The pictures below show the back of the Dark Side of the Moon album cover. On the left is the normal view and on the right it is flipped upside down.



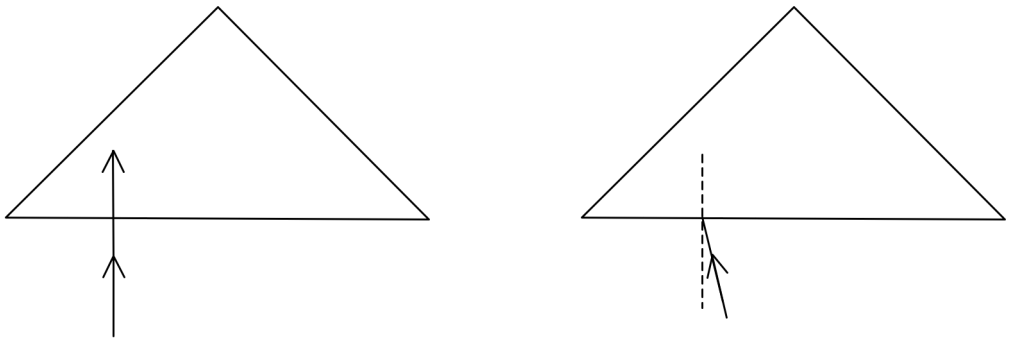


As we discussed in class, the view on the left looks like light is coming into the prism and coming together to produce white light. However, the picture violates "time reversal symmetry", as is clearly seen in the view on the right. If the view on the left were correct, then the view on the right would look correct for white light entering the prism and being spread into a spectrum, but the view on the right is clearly not correct. One problem is that the light inside the prism in not split into colors, but that is just the tip of the iceberg. Compare the view on the right to figure 24-15 in your textbook and identify at least three mistakes.

5) Light enters a 45-45-90 triangular prism of a pair of binoculars at normal incidence, as shown in the left figure below.
a) What is the minimum index of refraction of the glass that will assure that the light undergoes total internal reflection (TIR) when it hits the first diagonal surface?

b) Suppose that the prism has an index of refraction equal to the value you calculated in a). If instead of entering the prism at normal incidence the light enters at an angle of incidence of 5º, as shown in the right figure. At what angle will the light hit the first

diagonal surface relative to the normal? Will this light undergo TIR when it hits the first diagonal surface?



6) Ch. 23 P41 You can do this problem the sophisticated way, showing that TIR occurs for any angle α as long as $n_{glass} > 1.42$, or you can do it in Excel (or with your calculator) by trying various angles for α and showing that in each case TIR occurs if $n > 1.42$.

Part II

7) Ch. 23 P44

8) Construct a ray diagram to find the image produced by an object located 40 cm from a lens with a focal length of 15 cm. Characterize the image as real or virtual, upright or inverted, and enlarged or reduced.

9) Ch. 25 P6

10) Ch. 25 P12 It says assume a lens-eye distance of 1.8 cm. To make it easier, just say it is 2 cm. This is the distance from the eye to the reading glasses.

11) Ch. 25 P13

12) An entomologist has a near point of 20 cm. She looks at a tiny beetle that is 0.15 cm long, holding it at her near point.
a) What is the angle subtended by the insect at her eye?
b) She now uses a magnifying glass with a focal length of 5 cm to view the insect. The lens is placed 4.5 cm from the insect and her eye is directly behind the magnifying glass. See Fig. 25-16 p.704 for an illustration. How far behind the lens is the image formed by the lens? Will she be able to focus on this image?
c) What is the length of the image of the beetle? What is the magnification?
d) What is the angle subtended by the image at her eye? What is the *angular* magnification?