SIMG-303-20033 Homework #4

Due W, 4/14/2004

0. Read Chapter 7 in the notes on *Propagation of "Waves"* (perhaps better named *Propagation of Light*) and sections 4.4-4.7 in Hecht (pp. 100 - 126).

1. Given an interface between water ($n_{water} = \frac{4}{3}$) and glass ($n_{glass} = \frac{3}{2}$), compute the transmission angle for a beam incident in the water at 45°. If the transmitted beam is reversed so that it impinges on the interface at the same angle that it was transmitted, show that the transmission angle is 45°.

2. A laser beam impinges on an air-liquid interface at an angle of 55° (measured relative to the normal to the surface). The refracted ray is observed to be transmitted at 40°. What is the refractive index of the liquid?

3. A glass plate 1 inch thick with plane-parallel faces and $n = 1.5$ is held horizontally 4 inches above a printed page. If the text is viewed at an angle θ measured relative to the normal to the surface of the glass, find the position of the image of the page formed by rays through the glass.

4. An immersed skindiver shines a flashlight at the surface of the water so that the beam makes an angle of 60° relative to the vertical. The refractive index of water is 1.33.

   (a) Where does the flashlight beam go? Assume that there is no transmitted beam of light if there is a reflected one.

   (b) Oil with index $n = 1.2$ is spread on the water. Now where does the beam of light go?

5. The air over a blacktop road is hottest near the surface of the road. The index of air high above the road surface us 1.003. An observer looking at the road from a distance is able to see the pavement only if looking at an angle of 89° or more (measured from the surface normal). Calculate the refractive index of the air at the surface of the road.

6. A ray of light is incident at an angle of 60° on one surface of a glass plate 20 mm thick that is in air. The refractive index of the glass is 1.5. Find the transverse displacement between the incident and emerging rays.

7. (OPTIONAL – EXTRA CREDIT) The bore of a cylindrical thermometer (i.e., the hole in the middle for the mercury) has diameter equal to half the outside diameter of the stem. The refractive index of the glass is 1.5.

   (a) Determine the apparent width of the column of mercury relative to the apparent width of the stem, assuming that the viewing distance is large compared to the diameter of the thermometer.

   (b) Determine the apparent width if the diameter of the bore is 2/3 the diameter of the stem? (HINT: draw the picture)