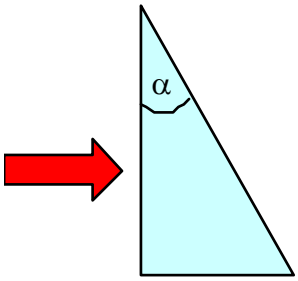
ELEC 262 Spring 2012 - Problem Set 4 **Distribution date: Wednesday, Feb. 1**
Reading: Hecht, Chapter 3, sections 4.1, 4.2, 4.8 **Due date: Friday, Feb. 10**
Lectures: 10, 11, 12, 13

NOTE: All students must sign up for an exam time slot in order to take exam 1. You must do this by email, before the beginning of class on Friday Feb. 10. Check the web page for details.

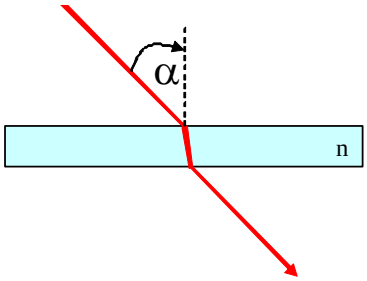
1. Consider an AM radio transmitter operating at 790 kHz. Based on the information given in lecture 10, determine the distance that this radio wave penetrates into the ionosphere. (That is, at this frequency, what is the skin depth of the ionosphere?) Would you expect any AM signal to leak through the ionosphere to outer space?

2. A cyclotron is a machine that sends charged particles (like electrons) round and round in a circular orbit. Assuming that the electrons accelerated in this device are moving at essentially the speed of light (in fact, they move at a tiny bit less than c_0, but the difference is insignificant for this problem), determine how much power each electron radiates. Assume that the radius of the circular orbit is 3 meters. This power is lost as the accelerating electron radiates electromagnetic waves. In which direction is there *no* radiation? You may be interested to know that there are several MUCH larger and more sophisticated versions of this device (now known as synchrotrons) in use throughout the world. They provide one of the brightest sources available for x-ray radiation, and are used to study all sorts of different types of materials.

3. In my lab, we have a laser which produces radiation over a range of wavelengths. At a particular time, the range of wavelengths in the laser beam spans the range from 770 nm up to 825 nm. If I shine this laser beam onto a prism, as shown in the diagram, what is the angular spread of the beam exiting from the prism? The prism is made of BK7 glass, whose properties can be modeled using the Cauchy formula (see problem set 3). The prism apex angle $\alpha = 30°$.



4. A laser beam is directed onto a beam splitter at an angle $\alpha = 30°$ relative to the surface normal, as shown in the illustration. The beam splitter has a refractive index n = 1.5 and a thickness d = 1 mm. When I remove the beam splitter, the beam falls directly onto the center of a detector. When I insert the beamsplitter, the light follows a 'dogleg' path and I must move the detector to re-center the beam. How far do I have to move the detector?



5. Unpolarized light is incident (from air) onto a smooth water surface, like a calm lake. Make a plot of the degree of polarization of the reflected wave as a function of the incident angle, over all possible values of θ_{in}. Degree of polarization is defined as:

$$d.o.p. = \frac{R_\perp - R_\parallel}{R_\perp + R_\parallel}$$

At what incident angle is the d.o.p. maximized? Over what range of incident angles is the light more than 50% polarized? For water, use $n = 1.33$.