Do any or all of the following activities.

1. Write down the real electric and magnetic fields for a monochromatic plane wave of electric field amplitude $E_0$, frequency $\omega$, and phase angle zero that is traveling from the origin toward the point (1,3,2) with polarization parallel to the x-z plane. Determine the energy density and energy flux density.

2. Under certain circumstances, an ionized gas is called a plasma. In this case, the electrons and positive ions are unbound. A simple way to model that is to consider the model in section 9.4.3, but with no binding force. Show that the complex dielectric constant looks like

$$\bar{\varepsilon}_r = 1 - \frac{\omega_p^2}{\omega^2 - i\gamma\omega} \text{ where } \omega_p \text{ is called the plasma frequency.}$$

Calculate the plasma frequency for the ionosphere (for which the density of charges is $\sim 10^{11}/m^3$). Assume that the damping is weak – i.e., $\gamma << \omega$ – and find the complex dielectric constant for frequencies above the plasma frequency and for frequencies below the plasma frequency. What is the complex wavenumber for these cases? Look at Table 9.1 and tell what frequencies of electromagnetic radiation pass through the ionosphere. For a “ham” radio signal, what is the phase difference between the electric and magnetic fields?

3. Assume you're standing at the shore watching unpolarized light reflect off a lake about three hours before sunset. What is the ratio of the horizontal component of the reflected electric field to the vertical component? If a pair of Polaroid glasses is oriented to absorb horizontal light, what fraction of the intensity passes through the glasses? Repeat the calculation if the reflection is off of a vertical glass building.

4. For the system of example 8.2, work out the force on the disk in detail.

5. In working through the details of the cylindrical waveguide, it's necessary to derive Eq. 9.180 in polar coordinates. Do so. Derive the equivalent of Eq. 9.181. Is it the same as the equation I solved in class?

6. Derive the equation of motion for a wave on a string without making the small amplitude approximation. Do so by keeping the second non-zero term in the Taylor series approximations.