Problem Set 3
Electrodynamics
Spring, '05
Due: April 29, 2005

Problem 1: Calculate the phase shift for totally internally reflected light for the transverse magnetic (TM) polarization. Is this phase shift the same as for the TE polarization? If plane polarized light is incident on the surface (but not necessarily polarized in the TE or TM mode), find the plane of polarization for the reflected light. Describe an experiment to measure the phase shift the TM mode.

Problem 2: Jackson 7.19

Problem 3: Jackson 7.22

Qualifying Exam Problems:

Do not use Mathematica on these problems.

Problem 3 – Spring, '93

A transverse magnetic plane wave is incident from a vacuum upon a dielectric surface at an angle θ. Using the continuity equations for the electric and magnetic fields at the surface of a dielectric, find the ratio of intensities of the reflected and transmitted waves to that of the incident wave. The dielectric material has $\varepsilon > \varepsilon_0$ and $\mu = \mu_0$. You may assume Snell's law and the law for the angle of reflection. Hint: Remember that the relationship between the maximum amplitudes of the magnetic and electric fields for a wave in the medium is:

$$\frac{|E|}{|H|} = \frac{\mu\omega}{\varepsilon}$$

Electricity and Magnetism, Question 2 – Spring, '05

A pulse of light is prepared at time $t = 0$ to have an electric field of the following form:

$$E_x = E_0 \cos kz \ \exp\left(-\frac{z^2}{2\sigma^2}\right)$$

with $\sigma \gg k^{-1}$. If the pulse is traveling in vacuum in the z-direction,

(a) Find the time dependent form of the electric and magnetic fields in the pulse.
(b) Find the energy and total momentum per unit area transmitted by this pulse.