University of California, Berkeley
Physics H7C Fall 1999 (*Strovink*)

PROBLEM SET 5

1.
It is known that, in Region 1 ($y > 0$, $\epsilon_1 = 4\epsilon_0$, $\mu_1 = \mu_0$), there exists a plane wave propagating in the $\hat{\mathbf{x}}$ direction.
a.
What is μ_2 in Region 2 ($y < 0$, $\epsilon_2 = \epsilon_0$)?
b.
What state(s) of polarization ($\mathbf{E}$ along $\hat{\mathbf{y}}$, $\hat{\mathbf{z}}$, or both) can the plane wave be in? Why?

2.
Fowles 2.23. Substitute "interface" for "window" – that is, consider just one glass-air interface, not two. The "degree of polarization" is defined by Fowles' Eq. (2.26).

3.
A beam of light travelling in the plane $y = 0$ is refracted by the interface $z = 0$ between two insulators: vacuum ($z < 0$) and a material ($z > 0$) with $\mu = \mu_0$ and with dielectric constant ϵ, where $\epsilon > \epsilon_0$. In the semi-infinite region $z < 0$, the angles of incidence and reflection, with respect to the z axis, are 60°. In the semi-infinite region $z > 0$, the angle of refraction, with respect to the same axis, is 30°.
(a.)
Taking the reflected and refracted angles to be as given, calculate ϵ/ϵ_0 for the material.
(b.)
The incident beam is right-hand circularly polarized. What is the state of polarization of the reflected beam? Explain your answer.
(c.)
Calculate the ratio R of irradiances

$$R = \frac{I_{\text{reflected}}}{I_{\text{incident}}} .$$

4.
Fowles 3.11.

5.
Fowles 3.13.

6.
Fowles 4.4.

7.
A camera lens is purplish because it is *optically coated* to minimize reflection at the center of the visible spectrum. (The coating parameters therefore are not optimized for red or blue light.)

Consider a plane EM wave in vacuum with wavelength λ normally incident on a semi-infinite piece of glass with refractive index $n > 1$ and unit permeability $\mu/\mu_0 = 1$. Choose the thickness and the refractive index of a coating on the glass in order to force the reflected wave to vanish.

8.
Show that the matrix equation (Fowles 4.24) for a single-layer film in fact is an equation that merely transforms the total (complex) E_T and H_T just to the right of the right hand interface to the total (complex) E_0 and H_0 just to the left of the left hand interface.

Show, therefore, that, for a multilayer film, the overall transfer matrix is equal to the product of the transfer matrices for the individual films, as (Fowles 4.28) asserts without proof.