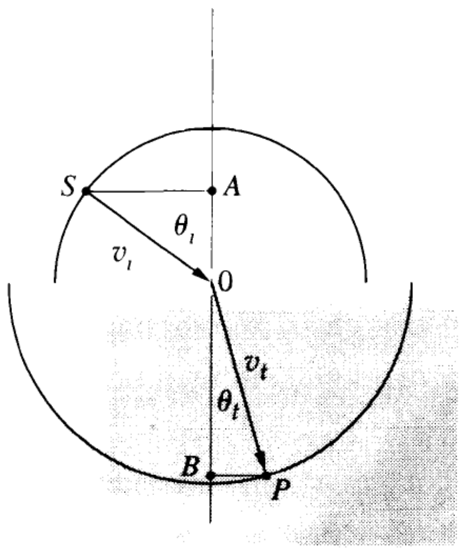
PHYS3038 Fall 2015
Homework #5
Due date: 13 Oct 2015

Problems:

4.10* The construction in Fig. P.4.10 corresponds to Descartes's derivation of the Law of Refraction. Light moves from S to O in the same time it travels from O to P. Moreover, its transverse momentum is unchanged on traversing the interface. Use all of this to "derive" Snell's Law.

Figure P.4.10



4.40* A beam of light in air strikes the surface of a smooth piece of plastic having an index of refraction of 1.55 at an angle with the normal of 20.0°. The incident light has component E-field amplitudes parallel and perpendicular to the plane-of-incidence of 10.0 V/m and 20.0 V/m, respectively. Determine the corresponding reflected field amplitudes.

4.46* Use Eq. (4.42) and the power series expansion of the sine function to establish that at near-normal incidence we can obtain a better approximation than the one in Problem 4.41, which is $[-r_\perp]_{\theta_i \approx 0} = (n-1)/(n+1)$, namely

$$[-r_\perp]_{\theta_i \approx 0} = \left(\frac{n-1}{n+1}\right)\left(1 + \frac{\theta_i^2}{n}\right)$$

4.68* Making use of the definitions of the azimuthal angles in Problem 4.67, show that

$$R = R_\parallel \cos^2 \gamma_i + R_\perp \sin^2 \gamma_i \tag{4.96}$$

and

$$T = T_\parallel \cos^2 \gamma_i + T_\perp \sin^2 \gamma_i \tag{4.97}$$

7.9 Use the complex representation to find the resultant $E = E_1 + E_2$, where

$$E_1 = E_0 \cos(kx + \omega t) \quad \text{and} \quad E_2 = -E_0 \cos(kx - \omega t)$$

Describe the composite wave.

7.18 Figure P.7.18 shows a carrier of frequency ω_c being amplitude-modulated by a sine wave of frequency ω_m, that is,

$$E = E_0(1 + a \cos \omega_m t) \cos \omega_c t$$

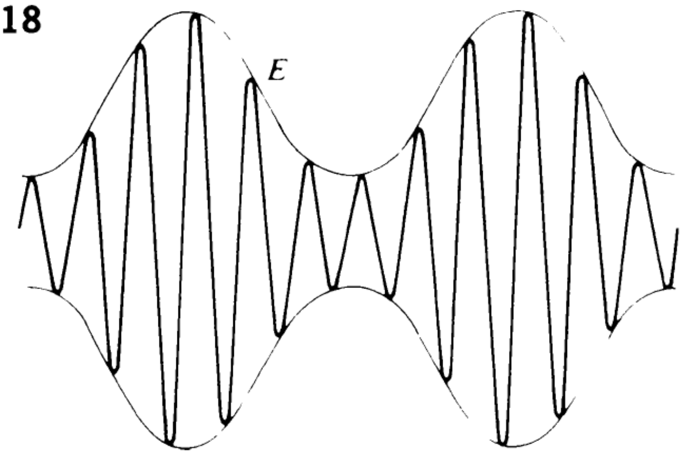
In the complex wave representation, it can be rewritten as:

$$E = E_0(1 + a\cos\omega_m t)e^{-i\omega_c t}$$

Show that this is equivalent to the superposition of three waves of frequencies ω_c, $\omega_c + \omega_m$, and $\omega_c - \omega_m$. When a number of modulating frequencies are present, we write E as a Fourier series and sum over all values of ω_m. The terms $\omega_c + \omega_m$ constitute what is called the *upper sideband*, and all the $\omega_c - \omega_m$ terms form the *lower sideband*.

What bandwidth would you need in order to transmit the complete audible range?

Figure P.7.18



7.24 Show that the group velocity can be written as

$$v_g = \frac{c}{n + \omega(dn/d\omega)}$$