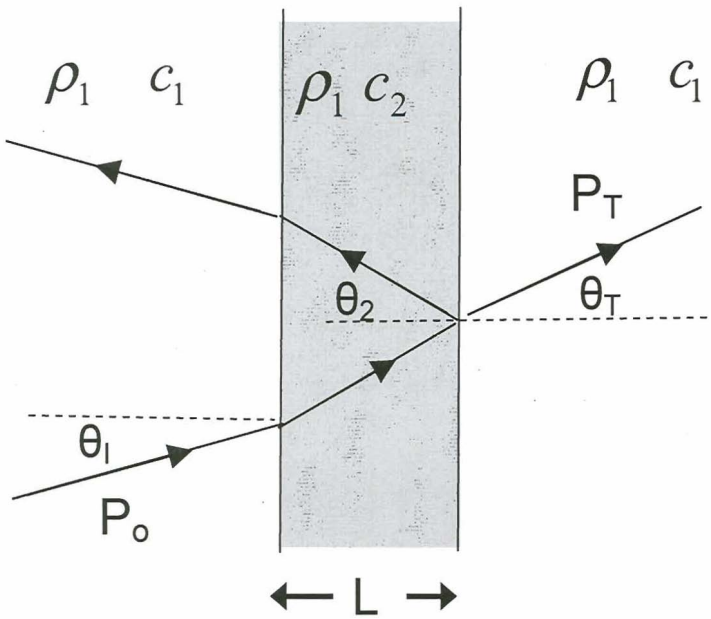

In the three layer reflection problem illustrated above, a sinusoidal sound wave of amplitude P_o is incident on a layer of thickness L at an angle θ_I which is greater than the critical angle. The parameters of the problem are as follows:

$$f = 10000\ Hz$$
$$\theta_I = 60^\circ$$
$$\rho_1 = 1000\ kg/m^3$$
$$c_1 = 1500\ m/s$$
$$c_2 = 3000\ m/s$$
$$L = 0.2\ m$$

a. What is θ_T?

b. **Estimate** the magnitude P_T. (Your answer should be a number times P_0)

Consider acoustic wave propagation in a waveguide such as in Fig.1 with a large width and very thin cross section. The thickness dimension, d, is small so that viscous losses can not be ignored. For simplicity, assume that these losses can be modeled by the slot flow resistance, $R = 12\mu/d^2$, the ratio of pressure drop per unit length to the average velocity over the cross section.
Here, μ is viscosity of air, given as 1.81×10^{-5} N·s/m^2, and $c_o = 343$ m/s.

a) Derive the one dimensional wave equation for particle velocity in this waveguide for the lowest propagation mode and obtain the propagation constant for time harmonic waves.

b) What is the phase velocity of these acoustic waves at 1kHz in a waveguide with d=10μm?

c) Consider the case in Fig.2 and find the impedance at 1kHz that would be measured by a small microphone at $x = 0$, which is at a distance $l = 2$ mm from a rigid end of this waveguide. What would be the impedance if l is very large?

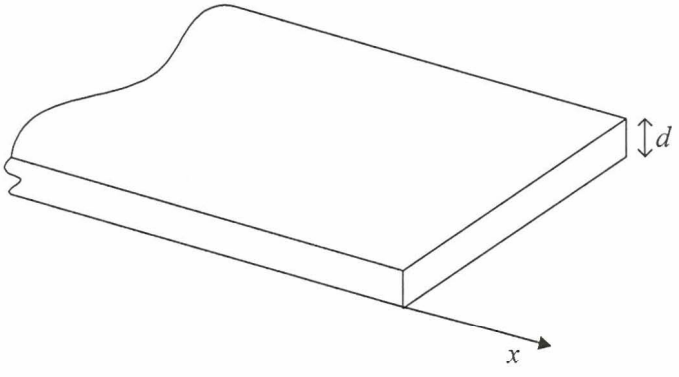

Figure 1

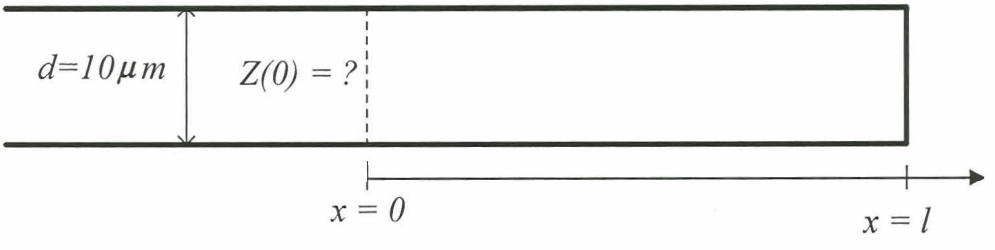

Figure 2

Two small spherical sources in the atmosphere are arranged as shown in the sketch. Both sources vibrate synchronously at 800 Hz. When B is turned off, it is observed that the sound-pressure level at position C is 80 dB referenced to 20 μPa. When both A and B are active the sound-pressure level at position C is 86 dB.

(a) Find the RMS pressure and the time-averaged intensity at position C due to both sources.

(b) Explain how the analysis in Part (a) would change if source A had a frequency of 600 Hz, and source B had a frequency of 1000 Hz.