Additional sound wave problems

Problem 1

A source produces a sound wave in air with frequency 1kHz. The maximum excess pressure is 0.03Pa. Air density is 1.20 kg/m^3 and speed of the wave is 344m/s. Find:

(a) maximum displacement of air molecules s_{max}

(b) maximum excess density

(c) maximum velocity of molecules associated with the displacement

Problem 2

(a) For the sound wave of problem 1, at a certain location at the instant where the excess pressure is 0.015Pa and increasing, what is the displacement at that location?

(b) And if instead the pressure is decreasing?

(c) What is the excess density or deficit in density for cases (a) and (b)?

Problem 3

The sound wave of problem 1 is traveling down a hollow tube of cross-sectional area 10cm^2 . Consider a small segment of that tube of length Δx=1cm.

(a) At an instant where the pressure in Δx is maximum, what is the net force acting on the air in that segment of the tube?

(b) At an instant where the pressure in Δx is zero, what are the possible values of the net force acting on that segment?

(c) For case (b), what are the possible values of the acceleration of the air molecules at that instant?

(d) I said the segment of the tube we are considering, of length Δx=1cm, is "small". Why does it need to be small? Small compared to what? Explain clearly what goes wrong if it's not "small".

Problem 4

(a) What is the intensity of that wave, in dB?

(b) How much energy crosses a cross-section of the tube per unit time (time averaged)?

Problem 5

Assume you are talking at a volume of 60dB. Estimate how long you would have to talk continuously to burn off the energy in a single M&M candy, about 3.4 kcal. (1kcal=4184 J). Assume the sound exits your mouth through an area of 5cm^2, and that your body is 100% efficient in converting food energy into sound energy.