Homework 13

Prerequisites: Read chapter 16.1 – 16.3. Skip the rest but review the lecture notes. If you are the Earth scientist, you might enjoy discussion in 16.11.

Problem 1 (5 points):

In class, we proved that in fluids the speed of a wave is $c = \sqrt{B/\rho}$, where B is the bulk modulus. Prove that c has dimension of meter per second.

Problem 2 (5 points):

Plug correct values for the speed of sound in the air and recalculate c more precisely than it was done in class. Compare your result with the "official" value of $c = 343$ m/s.

Problem 3 (5 points):

Which of the following excitations go to the positive direction of the 'x' axis and which ones go to the negative directions?

$$U(x,t) = g(ct - x) \tag{1}$$

$$U(x,t) = U_o \exp\left(-(x/10 - t)^2\right) \tag{2}$$

$$U(x,t) = \exp(ikx - iwt), \quad k > 0, \quad w > 0 \tag{3}$$

What changes if 'k' is a negative number in the above expression?

$$U(x,t) = \sin(x - t) + \cos(x + t) \tag{4}$$

Problem 4 (5 points):

A string of length L with a linear mass density μ is suspended in the Earth gravitational field. To the lower end of the string a mass m is attached. Assume that acceleration due to gravity g is constant.

How long does it take for an excitation to travel from one end of the string to the other?

To do it, you need to calculate

$$t = \int_0^L \frac{dy}{c(y)} \tag{5}$$

where 'y' is the position along the string.

Now consider a case when there is no attached mass to the end of the string. In this case, c is zero at the very bottom. So it should take infinite time to travel the very bottom part of the string. Yet, the overall time is still finite for $m = 0$. Please explain.