P6317 Assignment I

Due, Tuesday, February 15, 2022

1) [5] Use the Huygen's wavelet concept to prove that the angle of incidence equals the angle of reflection for a plane wave reflecting from a planar surface.

2) [5] Prove that sound free to radiate in a three dimensional domain will decay in intensity in proportion to $1/R^2$ while sound constrained to two dimensions will decay in proportion to $1/R$.

3) [10] A point radiates 1000 W of acoustic power at 1000 Hz in a 7000 m deep ocean. Plot a graph of the rms pressure as a function of range from 1 to 10000 m. (Use log-log axes). Repeat the calculation if the sound source is in the arctic where the water is only 50 m deep (ignore any energy loss with bottom and surface interactions). Repeat both calculations assuming a 50000 Hz source. In each case, what would the sound level be in dB (re 1 μPa) at a range of 10,000 m.
(warning, think carefully about whether spherical or cylindrical spreading or some combination of the two is appropriate, passing off between the two requires some caution.)

4) [5] For the CTD profile provided on the course homepage:
(http://brigus.physics.mun.ca/~zedel/P6317/P6317_19.htm),

plot profiles of temperature, salinity, and sound speed as a function of depth. (the columns in ctdprofile.dat are; depth (m), temperature (celsius), salinity (psu), and I don't know what the other columns are.) To estimate sound speed use the relation:

$$C = 1449.2 + 4.6T - 0.055T^2 - 0.000291T^3 + (1.34 - 0.01T)(S - 35) + 0.016Z. \quad (1)$$

Explain the shape of the sound speed profile in relation to the temperature and salinity profiles; what factors are important at what depth intervals.

5) [5] There is a set of standard routines for calculating many seawater parameters at: http://www.teos-10.org/. If you search around you should be able to find a routine for sound speed. Plot that version of the sound speed over your result from problem 4. Comment on the differences.

6) [5] If you consider that $u = u(x - Ct)$, show that:

$$\frac{\partial u}{\partial t} = -C\frac{\partial u}{\partial x}$$