Homework 7 -Phys273-Spring 2003

Tuesday April 15, 2003, by 9.30 am

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<u>**Problem 1**</u>[*10 points*]

One clue used by your brain to determine the direction of a source of sound is the time delay Δt between the arrival of the sound at the ear closer to the source and the arrival time at the farther ear. Assume that the source is distant so that a wavefront from it is approximately planar when it reaches you, and let D represent the distance between your ears. The velocity of sound in air is $v = 343$m/s, while the velocity of sound in water at 20 degrees Celsius is about four times larger $v_w = 1482$m/s.

(a) Find the expression that gives Δt in terms of D, the angle θ between the direction of the source and the forward direction (see figure below) and the velocity of sound in air v.

(b) Suppose that you are submerged in water at 20 degrees Celsius when a wavefront arrives directly to your right. Based on the time delay, at what angle θ from the forward direction does the source seem to be?

$$y(x,t) = y_m \ sin(kx \pm \omega t), \tag{1}$$
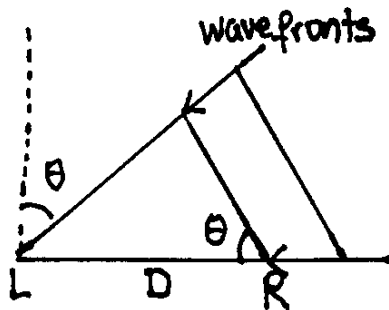
<u>**Problem 2**</u> [*10 points*]

A hawk is flying directly away from a bird watcher and directly toward a cliff at a speed of 15m/s. The hawk produces a shrill cry whose frequency is 800Hz.

(a) What is the frequency of the sound that the bird watcher hears directly from the bird?

(b) What is the frequency that the bird watcher hears in the echo that is reflected from the cliff?