Exam # 4 – Physics 152
Oscillations, Waves, and Sound

April 28, 2008

Be sure to include pictures, coordinate systems, etc. where reasonable.

1. (9pts)

   (a) How does the period T, frequency f, and angular frequency of a wave ω relate to each other?

   (b) How does the wavelength λ and wavenumber k of a wave relate to each other?

   (c) In the oscillation of a mass on a spring the position of the mass is the quantity that exhibits simple harmonic motion. For a pendulum, what is the quantity that exhibits simple harmonic motion?

2. (15pts) A sinusoidal wave on a piece of string has a peak at $t = 0s$ and $x = 0$

$$y(x,t) = 3cm cos(4\pi x + 5\pi t) \qquad (1)$$

   with an amplitude of $y = 3cm$. The wavelength of the wave is $\lambda = 0.5m$ and the period of the wave is $T = .2s$

   (a) Sketch a snapshot of the wave at $t = 0$.

   (b) What is the wavelength of the wave?

   (c) Sketch a movie of the wave at $x = 0$.

   (d) What is the period of the wave?

   (e) What is the speed of the wave?

3. (12pts) Two loudspeakers are located $4m$ apart on an outdoor stage. A listener is $18.2m$ from one and $19m$ from the other. During the sound check, a signal generator drives the two speakers in phase with the same amplitude and frequency. The transmitted frequency is swept through the audible range ($20Hz$ to $20kHz$).

   (a) What are the three lowest frequencies at which the listener will hear a **minimum** signal because of destructive interference?

(b) What are the three lowest frequencies at which the listener will hear a **maximum** signal?

(c) Describe qualitatively what is happening to cause a maximum signal. Include a sketch to support your description.

4. (15pts) The figure shows the shape of the pulse on a stretched string at the time $t = 0s$. The displacement of the spring from its equilibrium position at that time is given by

$$F(x) = Ae^{-(x/b)^2} \tag{2}$$

The pulse is moving in the positive x-direction with a velocity of v.

(a) Sketch a graph showing the shape of the spring at a later time, $t = t_2$. Specify the height and position in terms of the symbols given.

(b) Write an equation for the displacement of any portion of the spring at any time $y(x, t)$.

(c) Sketch a graph of the velocity of the piece of spring at the position $x = 2b$ as a function of time. You need not label the maximum velocity in terms of the given symbols.
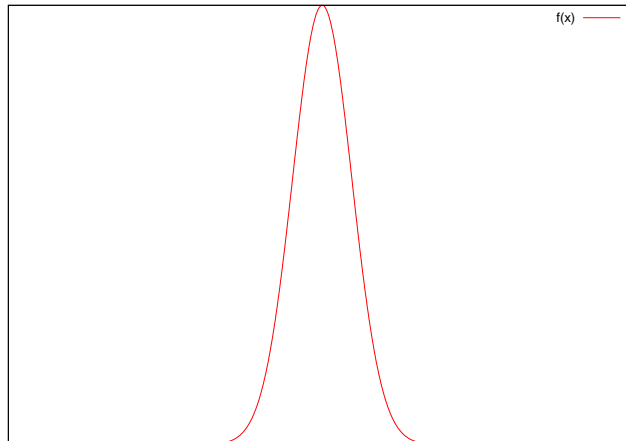
5. (10pts) It is Christmas time and you have used up a roll of wrapping paper and hum in your friends ear with it. To the extent that the tube and air do not absorb sound waves how does the intensity of the sound wave vary along the length of the tube? Base your answer on the same kinds of power arguments used in class and in the homework. Ignore all interference effects.