Tutorial Quiz-7 **PHYS 101 : Week of October 29, 2007**

Two problems to be done during the first hour on the black board and two to be handed in for marking

For the problems to be marked each problem is worth 10 points
A student may discuss the problems with other students but may not copy from others.

Problem 20.40

The displacement of a traveling wave is

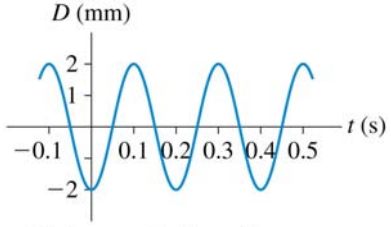
$$D(x,t) = \begin{cases} 1 \text{ cm} & \text{if } |x-3t| \le 1 \\ 0 \text{ cm} & \text{if } |x-3t| > 1 \end{cases}$$

where x is in m and t in s.

(a) Draw displacement-versus-position graphs at 1 s intervals from t = 0 to t = 3 s. Use an x-axis that goes from -2 to 12 m. Stack the four graphs vertically.
(b) Determine the wave speed from the graphs. Explain how you did so.
(c) Determine the wave speed from the equation for Does it agree with your answer to part b?

Problem 20.43

This is a history graph at x = 0 of a wave traveling in the positive x-direction at 4.0 m/s



History graph at x = 0 m
Wave traveling right at 4.0 m/s

(a) What is the wave length?
(b) What is the phase constant of the wave?
(c) Write the displacement equation for this wave.

Problem 20.44

An ultrasound unit sends a 2.4 MHz sound wave into a 25-cmlong tube filled with an unknown liquid. A small microphone right next to the ultrasonic generator detects both the transmitted wave and the sound wave that has reflected off the far end of the tube. The two sound pulses are 4.4 divisions apart on an oscilloscope for which the horizontal time sweep is set to 100 ms/division. What is the speed of sound in the liquid?

Problem 20.63

A sound wave of frequency 686 Hz is traveling in 20°C air as a plane wave in the positive *y*-direction. At time $t = 0$ s, one crest of the wave is located in the plane $y = 12.5$ cm.

a. Draw a graph of $D(y, t = 0 \text{ s})$ as a function of y from $y = -150$ cm to $y = +150$ cm.

b. What is the phase constant for this wave? There are *two* values that satisfy the mathematics, so justify your answer.

c. Write the wave equation $D(y,t)$ for the wave, leaving the amplitude A unspecified.

d. Draw an *xy*-coordinate system in which *y* ranges from -150 cm to +150 cm. Show the wave fronts of the wave at time $t = 0$ s. Number each of the wave fronts (1, 2, . . .) at the side of the graph.

e. Repeat part d at time t = 0.729 ms. Keep the same number attached to each wave front so that you can see how the wave fronts have moved.

f. At $t = 0.729$ ms, what is the phase of the wave at and at $y = 12.5$ cm and at $y = -12.5$ cm?

Problem 20.71

The sound intensity 50 m from a wailing tornado siren is 0.10 W/m^2.
a. What is the intensity at 1000 m?
b. The weakest intensity likely to be heard over background noise is $\approx 1\mu$ W/m^2 .Estimate the maximum distance at which the siren can be heard.

Problem 20.73

A bat locates insects by emitting ultrasonic “chirps” and then listening for echoes from the bugs. Suppose a bat chirp has a frequency of 25 kHz. How fast would the bat have to fly, and in what direction, for you to just barely be able to hear the chirp at 20 kHz?

Problem 20.74

A physics professor demonstrates the Doppler effect by tying a 600 Hz sound generator to a 1.0-m-long rope and whirling it around her head in a horizontal circle at 100 rpm. What are the highest and lowest frequencies heard by a student in the classroom?

Problem 20.82

A rope of mass *m* and length *L* hangs from a ceiling.
a. Show that the wave speed on the rope a distance *y* above the lower end is $v = \sqrt{gy}$
b. Show that the time for a pulse to travel the length of the string is $\Delta t = 2\sqrt{L/g}$