Student No. SOLUTION Last Name____________ First Name ______________

The University of British Columbia
Physics 101, Section 102 **Nov 09, 2007** **Midterm 2B**

No books or notes are permitted. Please do all questions.

1: The plots (on the next page) show the displacement of a transverse wave as a function of time and position. The displacement plot was acquired at t = 1 s and the position plot was acquired at x = 1 m.

(8 points)

(a) Find the **Time period (T)**, **wavelength (λ)** and **wave speed** for this wave.

$T = 1.05$ s

$\lambda \cong 3.1$ m

$V = \lambda f = \frac{\lambda}{T} = 2.95$ m/s

(b) What is the phase constant for this wave?

$$D(x,t) = 0.5 \sin\left(\frac{2\pi}{3.1}x \mp \frac{2\pi}{1.05}t + \phi\right)$$

$$\therefore D(1,t) = 0.5 \sin\left(\frac{2\pi}{3.1} \mp \frac{2\pi}{1.05}t + \phi\right)$$

Consider t = 0 point.

$$D(1,0) = 0 = 0.5\sin\left(\frac{2\pi}{3.1} + \phi\right) \Rightarrow \sin\left(\frac{2\pi}{3.1} + \phi\right) = 0 \Rightarrow \phi = -\frac{2\pi}{3.1}$$

$\cong -2.03$ rad

(c) Is the wave moving towards positive x-axis or towards negative x-axis?

$$D(1,t) = 0.5 \sin\left(\frac{2\pi}{3.1} \mp \frac{2\pi}{1.05}t - \frac{2\pi}{3.1}\right)$$

$$D(1,t) = 0.5 \sin\left(\mp \frac{2\pi}{1.05}t\right)$$

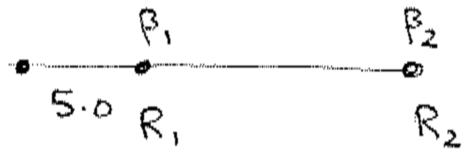
Since D(1, 0.1) is positive, we must have + sign ∴ Negative X-axis

(c) Write down the complete equation, D(x,t) for this wave, with all constants evaluated.

$$D(x,t) = 0.5 \sin\left(\frac{2\pi}{3.1}x + \frac{2\pi}{1.05}t - \frac{2\pi}{3.1}\right)$$

2: You are standing 5.0 meters away from a noisy construction drill. To get away from the noise you start walking away from the drill. You want to reduce the sound level by 30 dB. How far away would you have to move? (5 points)

$$\beta_1 - \beta_2 = 10 \log\left(\frac{I_1}{I_2}\right)$$



$$I_1 = \frac{P}{4\pi R_1^2} \; ; \quad I_2 = \frac{P}{4\pi R_2^2}$$

$$\beta_1 - \beta_2 = 10 \log\left(\frac{R_2^2}{R_1^2}\right)$$

Given : $\beta_1 - \beta_2 = 30$ dB.

$$30 = 10 \times \log\left(\frac{R_2^2}{R_1^2}\right) \Rightarrow 3 = \log\left(\frac{R_2^2}{R_1^2}\right)$$

$$\frac{R_2^2}{R_1^2} = 10^3 = 1000 \qquad R_2^2 = R_1^2 \times 1000 = 25000$$

$$\boxed{R_2 \cong 158 \text{ m}}$$

3: A string under tension carries transverse waves traveling at speed V. If the same string is under four times the tension, what will be the wave speed? (please circle only one answer) (3 points)

(1) 0.25 V (2) 0.5 V (3) V (4) 2V (5) 4V

4: Two identical pulses of opposite amplitudes travel along a stretched string and interfere destructively. Which of the following is/are true? (Please circle correct answer(s)). (3 points)

(1) There is an instant at which the string is completely straight.

(2) When the two pulses interfere, the energy of the pulses is momentarily zero.

(3) There is a point on the string that does not move up or down.

(4) There are many points on the string that do not move up or down.

5: Car A is at rest and is sounding its horn. Car B is moving at speed v_0 towards car A. Frequency of car A's horn is measured by an observer in car B to be f. What will be the frequency of car A's horn, as measured by the observer in car B, if car B is at rest and car A moves at speed v_0 towards car B? (v_0 is less than the speed of sound in air)

(6 points)

(1) f (2) Greater than f (3) Less than f

(4) $2f$ (5) $f/2$

Please show your work and reasoning below. No marks without the work.

f_A A ← V_0 B

$$f = f_A\left(\frac{V+V_0}{V}\right) \quad (1)$$

f_A A → V_0 B

Let f_1 be frequency measured by B

$$f_1 = f_A\left(\frac{V}{V-V_0}\right) \quad (2)$$

From (1) $$f_A = f\left(\frac{V}{V+V_0}\right)$$

$$\therefore f_1 = f\left(\frac{V}{V+V_0}\right)\left(\frac{V}{V-V_0}\right) = f\left(\frac{V^2}{V^2-V_0^2}\right) = f\left(\frac{1}{1-\frac{V_0^2}{V^2}}\right)$$

$$\therefore f_1 > f$$

6: Listed below are equations for traveling waves, where x and D(x,t) are in meters and time t in seconds (5 points)

A: D(x,t) = 2 sin (3x + 2t)	**B:** D(x,t) = 3 sin (-4x - 4t)	**C:** D(x,t) = 5 sin (5x - 7t)
D: D(x,t) = 7 sin (7x - 20t)	**E:** D(x,t) = 4 sin (9x - 9t)	**F:** D(x,t) = 2 sin (x + t)

(1) Rank the waves from least to greatest in order of **wavelength**, indicating any equality

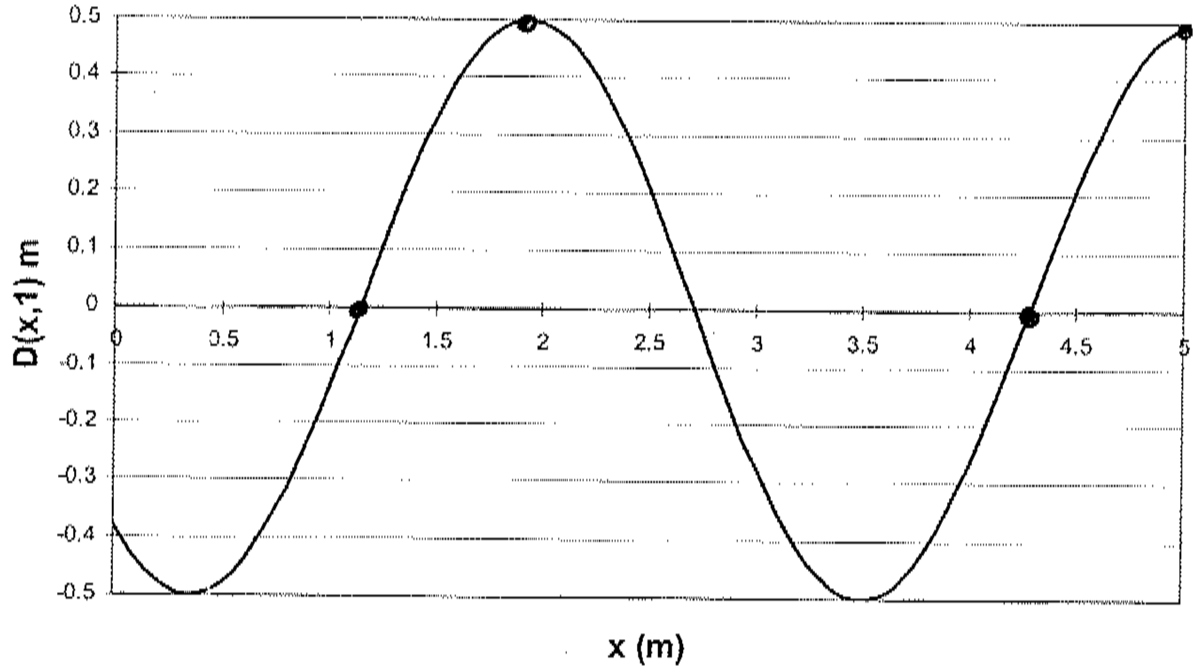
Least E, D, C, B, A, F **Greatest**

(2) Rank the waves from least to greatest in order of **wave speed**, indicating any equality

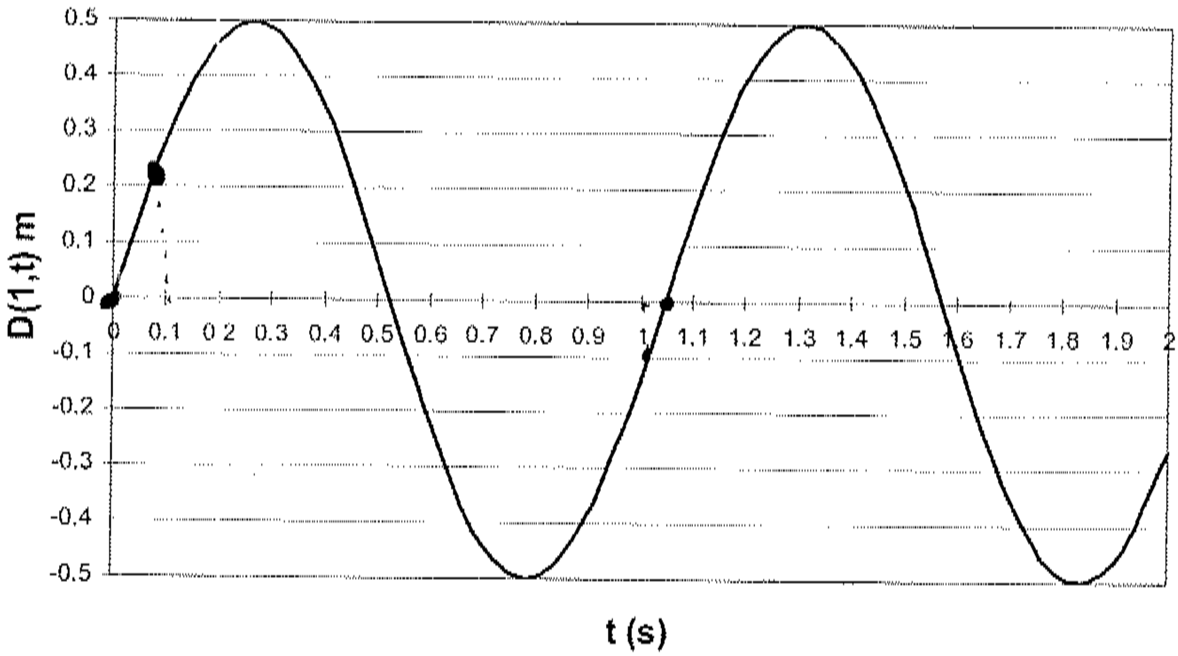
Least A, E = F = B, C, D **Greatest**

(3) Which waves are traveling in negative x-direction?

A, B, F



0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
D(x,1) m
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
x (m)



0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
D(1,t) m
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
t (s)