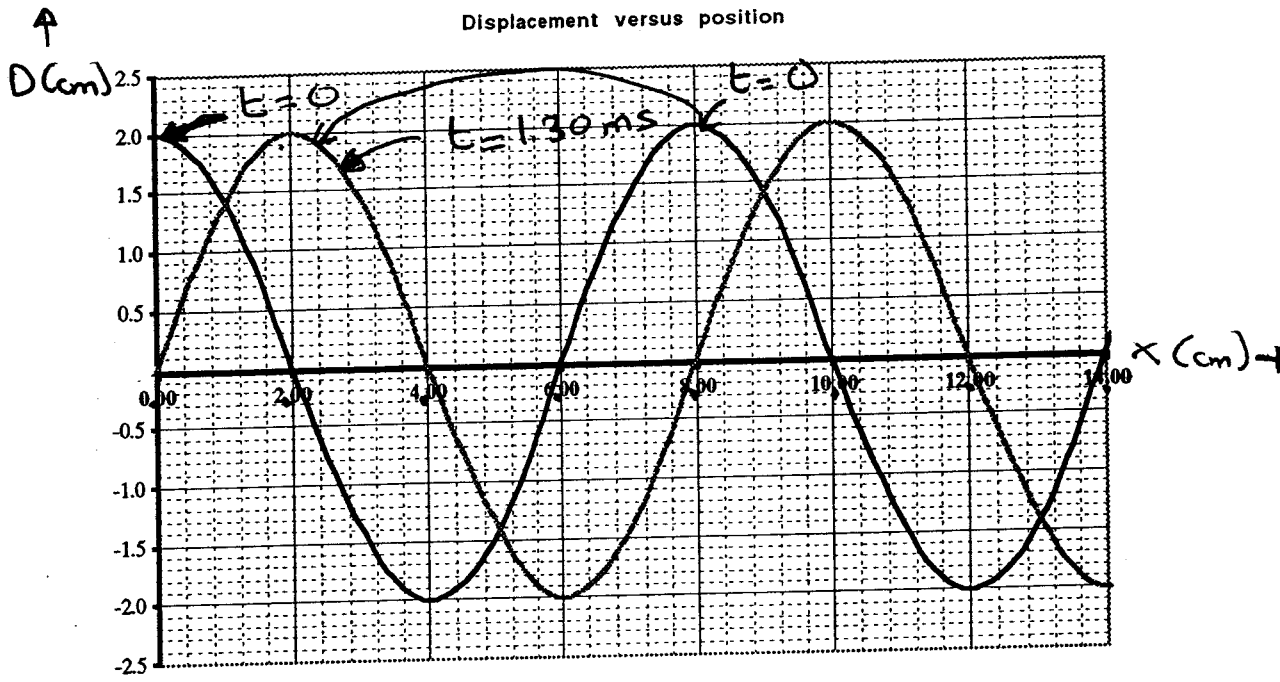
Student #: Ans Key Name: _____

Physics 101 Midterm2 20003W

(7) **1.** The figure following shows the displacement of a sinusoidal wave travelling in the negative x-direction along a stretched string as a function of position (x) at time t = 0.00 s and t = 1.30 ms. Determine:



a) the wavelength $\lambda = 0.080\,m \Rightarrow k = 25\pi$

b) the wavespeed to left $\therefore$ 6cm in 1.3ms $v = \frac{0.06\,m}{1.3\times10^{-3}\,s} = 46.1\,m/s$

c) the period $T = \frac{\lambda}{v} = 1.73\,ms$ $\omega = \frac{2\pi}{T} = 1154\pi\ rad/s$

d) write an equation to describe the motion – include a numerical value for the phase constant ϕ.

$D = (0.020\,m)\cos(25\pi x + 1154\pi t)$ $\phi = 0$

or $(0.020m)\sin(25\pi x + 1154\pi t + \frac{\pi}{2})$

e) what is the maximum and minimum particle speed for an element of the string?

$\omega A = 1154\pi \times 0.02 = 72.5\,m/s$ (max)

min speed is 0 m/s

(3) **2.** A damped harmonic oscillation, losses 6.0% of its mechanical energy per cycle. After how many periods will the amplitude have decreased to 30% of its original value?

$\frac{E}{E_0} = e^{-\frac{b}{m}T} = 0.94 \rightarrow \ln 0.94 = -\frac{b}{m}T \rightarrow \frac{b}{m} = \frac{0.0619}{T}$

$\frac{A}{A_0} = 0.3 = e^{-\frac{n\pi\cdot0.0619}{2\pi}}$

$n \times 0.0310 = 1.204$

$n = 39$

(3) **3.** When a 70.0 cm long pipe is immersed in a gas (not air!) the frequency of one overtone is 280 Hz and the next overtone is 350 Hz. 350 → 280 → 210 → 140 → 70

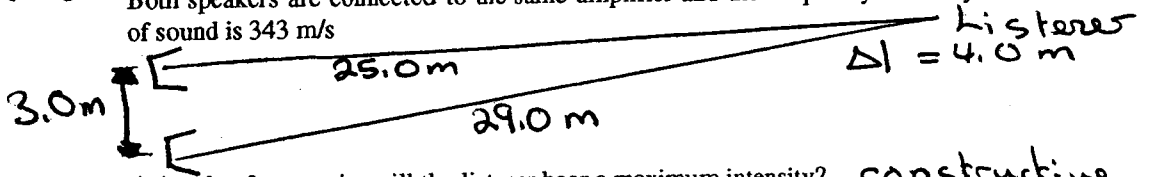
i) determine the fundamental frequency of the pipe, is it open or closed?

70 Hz see overharmonics ∴ open both ends

ii) determine the speed of sound in the gas.

70 Hz → $\lambda = 0.70 \times 2 = 1.4$ m $v = \lambda f = 1.4 \times 70 = 98$ m/s

(3) **4.** Two loud speakers are located 3.00 m apart. A listener is sitting 25.0m from one speaker and 29.0 m from the other. Both speakers are connected to the same amplifier and the frequency is slowly varied from 20 to 300 Hz. If the speed of sound is 343 m/s



a) At what frequencies will the listener hear a maximum intensity? constructive ∴ $\Delta l = n\lambda$

$n=1$ $\lambda = 4$m $f = \frac{343}{4} = 85.8$ Hz (86)

$n=2$ $\lambda = 2$m $f = \frac{343}{2} = 171.5$ Hz (171.5)

$n=3$ $\lambda = \frac{4}{3}$ $f = \frac{343}{\frac{4}{3}} \times 3 = 257$ Hz (257)

b) At what frequencies will the listener hear a minimum intensity? $\Delta l = \frac{(2n-1)\lambda}{2}$

$n=1$ $\lambda = 8$m $f = \frac{343}{8} = 43$ Hz

$n=2$ $\lambda = \frac{8}{3}$ m $f = \frac{343}{8} \times 3 = 129$ Hz

$n=3$ $\lambda = \frac{8}{5}$ m f . . . . 214 Hz

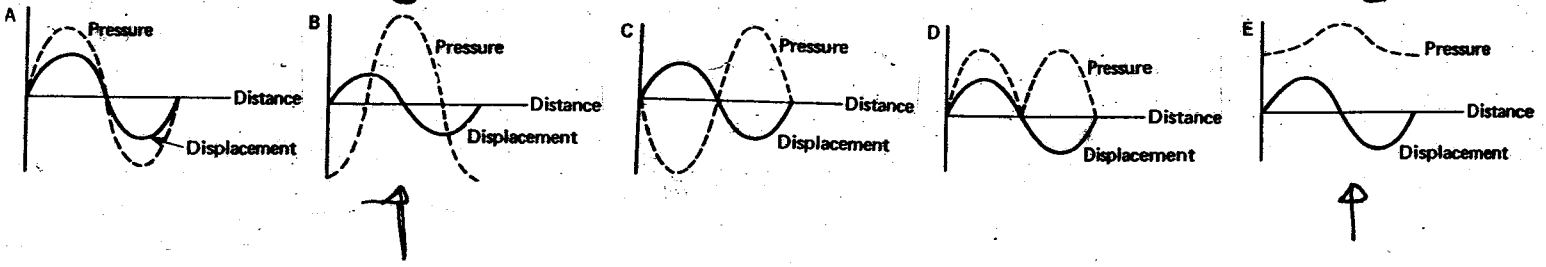
(1) **5.** The intensity of sound wave A is 100 times that of sound wave B. Relative to wave B the sound level of wave A is:

10 log 100

a) –2 dB b) +2 dB c) +10 dB (d) +20 dB e) +100 dB

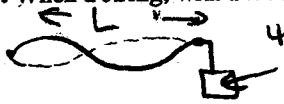
1 (1) **6.** Which of the following graphs represents the displacement from equilibrium and the variation of air pressure at a particular instant for a sinusoidal sound wave?

change in P



Pressure

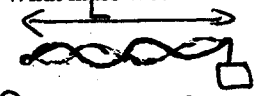
(2) **7.** When a string, with a mass of 430 grams attached to it, is shaken at a frequency of 120 Hz 2 "loops" are observed.



$\lambda = L$

same

What mass would need to be attached to the string if four loops are observed. For $f = 120$ Hz.



$\lambda = \frac{L}{2}$

λ ↓ factor 2

∴ v ↓ factor 2

∴ T ↓ factor 4

→ $\frac{430}{4} = 107$ grams