First Letter Last Name

Name: Ans Key Student Number: _____

PHYS 101 Mid-term 2 November 7, 2007

Marks

Q1 (7)	Q2 (8)	Q3 (8)	Q4 (7)	Total (30)

It is recommended that you use pen – if you use pencil then any requests for regrading may be denied.
Simple scientific calculator

Question 1 a) Circle the correct answer (1 mark)
Standing waves are produced by the superposition of two waves with

(1)
A) the same amplitude, frequency, and direction of propagation
B) the same amplitude and frequency, and opposite propagation directions.
C) the same amplitude and direction of propagation, but different frequencies.
D) the same amplitude, different frequencies, and opposite directions of propagation.

Question 1b) (6 marks)
Listed below are the equations for traveling waves, where x and y are in metres and, t is in seconds and the numerical values have the appropriate units.

ω/k 4/4 8/3 6/4

A $y = 6\sin(4x + 4t)$ **B** $y = 4\sin(-3x + 8t)$ **C** $y = 3\sin(4x + 6t)$

3/6 6/6 8/2

D $y = -6\sin(-6x + 3t)$ **E** $y = 4\sin(-6x - 6t)$ **F** $y = 3\cos(2x - 8t)$

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

Greatest F > B > A = C > D = E Least

= smallest k

ii) Rank the waves from greatest to least in order of **wavespeed**, indicating any equality:

(2) Greatest F > B > C > A = E > D Least

iii) Which waves are traveling in the negative x-direction? Show your reasoning.

A $4x+4t$ = const if t↑ x↓
B $-3x+8t$ = const if t↑ x↑
C $4x+6t$ as A
D $-6x+3t$ as B
E $-6x-6t$ = const if t↑ x↓
F $2x-8t$ = const if t↑ x↑

A C E

(2)

Reasoning 1 mark
miss 1 −½

Question 2a (4 marks)

A student wishes to measure the depth of a well, which can be modeled as a pipe closed at one end. She uses a loud speaker to generate acoustic resonances. She hears a resonance at 170 Hz and the next resonance is at 190 Hz. Assume the speed of sound in air is 343 m/s. 90 110 130 150 170 190

i) What is the lowest resonant frequency for the well? 10 30 50 . -.

(1) 10 Hz

ii) What is the depth of the well?

(2) $L = \frac{\lambda}{4} = \frac{343}{40} = 8.58$ m

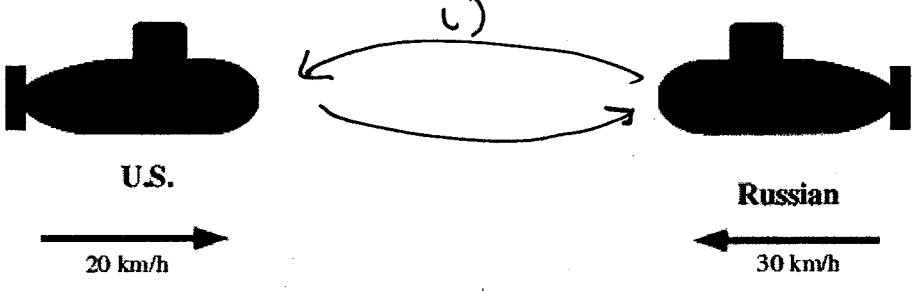
iii) Which harmonics did she hear? 17th & 19th

(1)

Question 2b (4 marks)

A U.S. submarine and a Russian submarine move toward each other in still water in the North Atlantic. The U.S. submarine moves at 20.0 km/h and the Russian submarine at 30.0 km/h. The Russian submarine sends out sonar (sound in water) waves traveling with a speed of 5,500 km/h and at a frequency of 1500 Hz.

$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$



check signs

i) What is the frequency detected by the U.S. submarine? source & detector towards

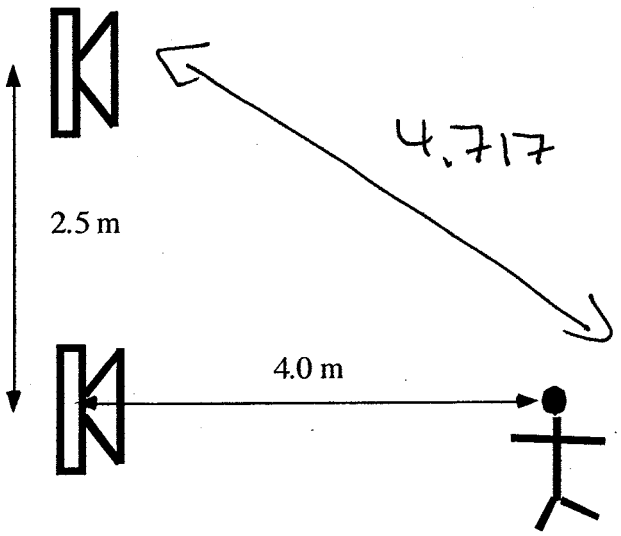
$v_s = 30$ km/h $v_o = 20$ km/h

(2) $f' = 1500\left(\frac{5,500 + 20}{5500 - 30}\right) = 1514$ Hz (mix up 1513.7)

ii) What is the frequency detected by the Russian submarine for the signal reflected back to it by the U.S. submarine? $v_s = 20$ km/h $v_o = 30$ km/h

(2) $f'' = f'\left(\frac{5500 + 30}{5500 - 20}\right) = 1527.5$ Hz

Question 3a (4 marks)



path difference

$\Delta x = 0.717\ m$ ... (1)

Two loud speakers, separated by a distance of 2.50 m, are in phase and produce sound waves of the same frequency. There is a listener 4.00 m in front of one speaker as shown. The frequency of the speakers is slowly increased from 20 Hz.

i) What are the three lowest frequencies at which the listener hears a maximum signal?

(2)

const $\Delta x = m\lambda$ $m=1$ $\lambda = 0.717^m$ $f = \frac{343}{0.717} = 478\ Hz$

$m=2$ $\lambda = 0.358\ m$ $f_2 = 957\ Hz$

(method = 1) $m=3$ $\lambda =$ $1435\ Hz$

ii) What are the three lowest frequencies at which the listener hears a minimum signal?

(1)

$\Delta x = (m+\frac{1}{2})\lambda$ $m=0$ $\lambda = 1.434\ m$ $f_1 = 239\ Hz$

$m=1$ $\lambda = 0.478\ m$ $f_2 = 718\ Hz$

$m=2$ $\lambda = 0.287$ $f_3 = 1196\ Hz$

Question 3b (3marks)

Twenty violins are played simultaneously with the same intensity. Together, they produce a sound level of 80.0 dB.

$80 = 10\log\frac{20I}{I_0} = 10\log\frac{I}{I_0} + 10\log 20$

If only one is playing:

i) What is the sound level (dB) of a single violin?

$80 - 10\log 20 = 67\ dB$

ii) What is the intensity of a single violin?

$6.7 = \log I/I_0 = \log I + 12$

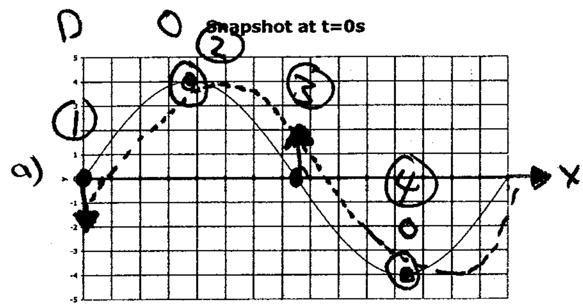
$\log I = 6.7 - 12 = -5.3$

$I = 1\times10^{-5.3} = 5.0\times10^{-6}\ W/m^2$

Question 4 (7 marks)
The identical figures at the side show a snapshot of a wave on a wire at t = 0. On the figures, sketch what the snapshot would look like at an **instant later** i.e. a time later that is **much** smaller than the period of oscillation for each of the following cases.

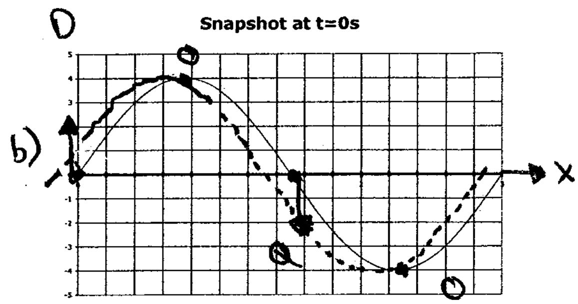
a) A wave traveling in the positive x-direction.

1



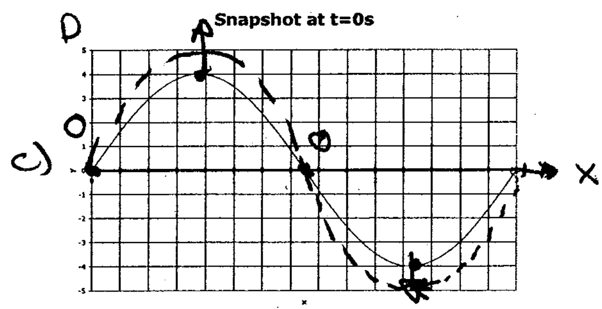
b) A wave traveling in the negative x-direction

1



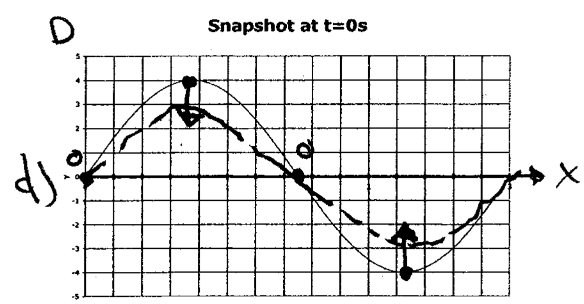
c) A standing wave with a displacement that at t=0 is increasing.

1



d) A standing wave with a displacement that at t=0 is decreasing.

1



e) On the above diagram for part a, four points on the wire are indicated. Indicate the velocity of a particle on the wire (use an arrow indicating the relative size and direction) at these points at the instant t = 0. Repeat for parts b, c and d.

2 (a & b — zero or v. small pts 2 & 4; correct dir → pts 1 & 3

1 (c & d — zero at pts 1 & 3; correct dir pts 2 & 4