

Physics 101: The Science of Sound

Final Exam version a, 12/14/05

Name _____

For questions with numerical answers, draw a box around your final answer.

Except as noted, correct answers get full credit. Incorrect answers get partial credit based on the work shown.

If any problem relies on a previous answer, scoring on that problem will be based on YOUR previous answer, whether or not it is correct.

WARNING!

Some problems may be very similar to, but subtly different from, problems from previous MiniTests. Read carefully; **do not** assume that everything is the same as on the previous MiniTests.

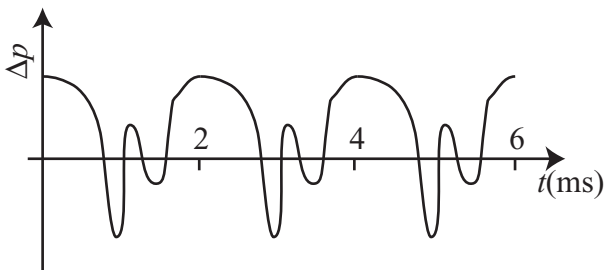
Scoring:

Raw Total: _____/140 pts

Adjusted Score: _____%

- 1) [10 pts] A spring in lab 2 of this course starts with no mass on it and the bottom at a position of 82cm. A mass of 150g is hung on it, and the position of the bottom of the spring moves to 69cm. If an *additional* 200g is added, what position do you expect for the spring bottom?

- 2) [10 pts] To the left is a periodic complex sound. Suppose that it is made up from four partials, including the 3rd, 4th, and 6th harmonics. List the frequencies of those partials below.



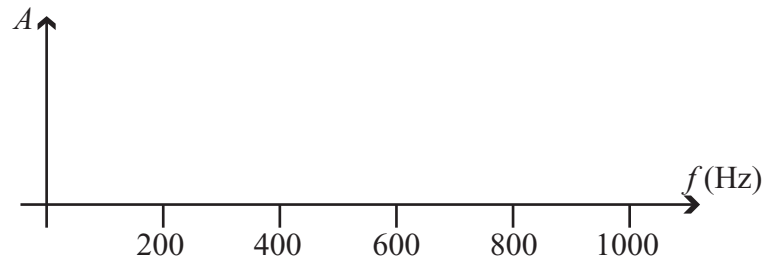
1st partial, $f =$ _____

2nd partial, $f =$ _____

3rd partial, $f =$ _____

4th partial, $f =$ _____

- 3) [10 pts] You are listening to two musical instruments, playing frequencies of 170Hz and 320Hz. The spectrum of the higher frequency instrument has all harmonics, while the spectrum of the lower frequency instrument has only odd harmonics. Sketch the combined spectrum on the axes given. What is the frequency of the 5th partial of the combined sound?



- 4) [10 pts] A trumpet is being played, generating $4.3 \times 10^{-4} \text{ W}$ of sound power. The opening of the trumpet bell is a circle with diameter 11cm. What is the Sound Intensity right at the trumpet bell?

5) [10 pts] List the following concepts in order from smallest to largest: (A) critical band width, (B) fusion frequency difference, (C) just noticeable difference. Just putting the letter is sufficient.

Then, on the axes to the right, illustrate the amplitude of the basilar membrane excitation when two notes are presented to the ear simultaneously with a frequency difference that is between the middle and largest entries on your list.

smallest: _____

largest: _____



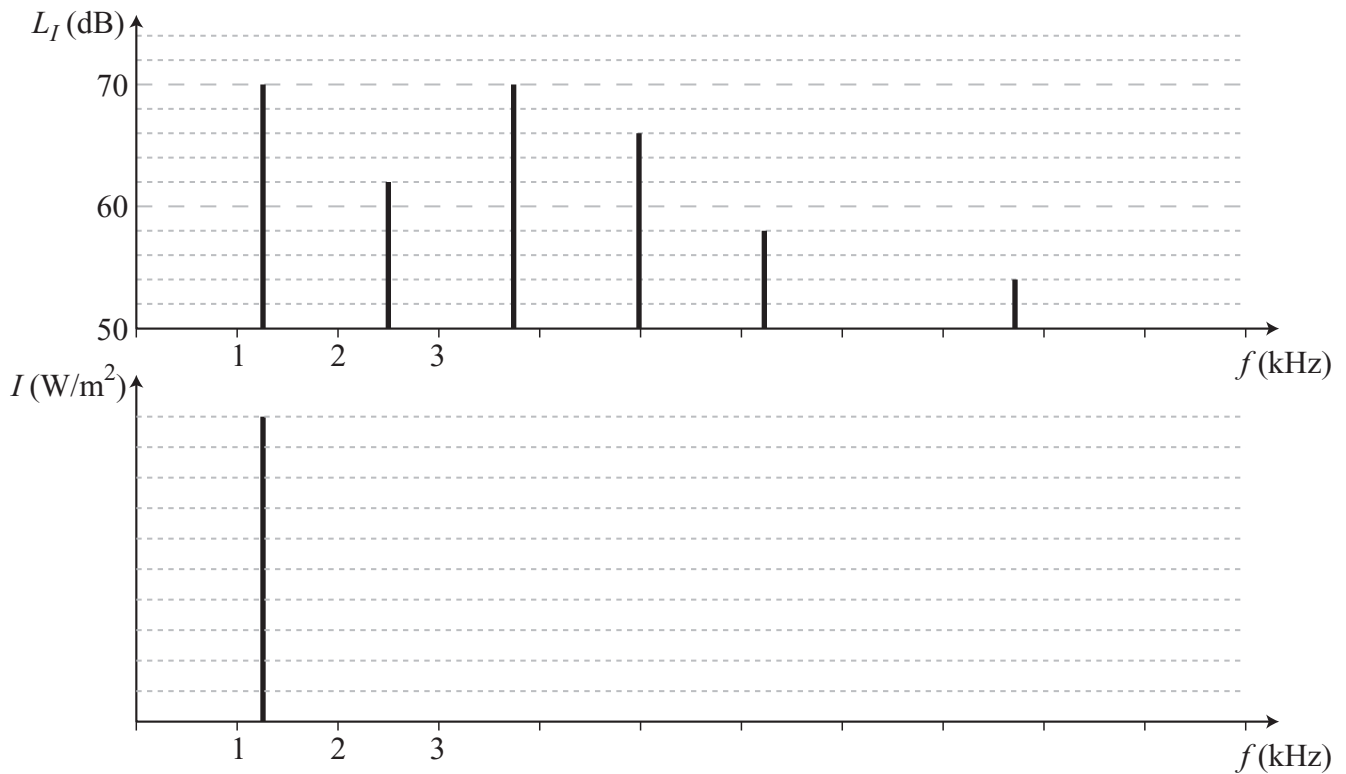
6) [10 pts] A speaker vibrates with an amplitude of 0.500mm, and 3m away the resulting intensity is $3.0 \times 10^{-4} \text{ W/m}^2$. If the amplitude is reduced to 0.350mm, what will the intensity be (at the same position)?

7) [10 pts] If the speaker in the previous problem is radiating sound in all directions, what is its sound power output for the first (larger) amplitude?

8) [10 pts] Write the letter of the appropriate "crossword clue" in front of each term.

- | | |
|--------------------------|-------------------------------------|
| _____ place theory | (A) pitches from repeating patterns |
| _____ absolute pitch | (B) can't hear a softer sound |
| _____ Fechner's law | (C) pitches from membrane position |
| _____ Ohm's law | (D) logarithmic sensation |
| _____ masking | (E) pitch identification |
| _____ periodicity theory | (F) phase doesn't matter |

9) [10 pts] Below is given the sound intensity level spectrum of a sound. Draw the corresponding intensity spectrum (with linear axes). Draw your peak heights accurately; for maximum clarity, label each peak with its intensity.



10) [10 pts] If the efficiency of a microphone is described as -22dB , it could also be described as ...

- (A) 13.4% (B) 0.63% (C) 133.4dB
 (E) 13.4 (F) 0.031 (G) 4.55%

11) [10 pts] Check of the appropriate attributes of the following waves. Check ALL that apply (may be more than one).

	<i>pure transverse</i>	<i>pure longitudinal</i>	<i>compression</i>	<i>pulse or wavepacket</i>	<i>continuous</i>	<i>1 dimensional</i>	<i>2 dimensional</i>	<i>3 dimensional</i>
a) wave made on a horizontal rope by shaking the end up and down for a long time								
b) wave made in a vertical slinky by rapidly moving the end up and down only once								
c) waves on a pond from dropping in a stone								
d) sound heard from the hum of an electric motor								
e) waves at an ocean beach								
f) a very rapid "pop" sound made by bats for echo-location								

12) [10 pts] In the following pictures of ropes, in the left column an incident pulse is shown in gray. To the right of each of these, draw what the reflected or transmitted pulses should look like and label them R and T. Only whether the pulse is up or down will be graded, not how wide it is. If there is a case where either a transmitted or reflected pulse doesn't exist, check off the appropriate box.

		Doesn't Exist	
		R	T
(a wall)			
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>

13) [10 pts] Circle the letter of the correct completion of this sentence. Circle more than one if appropriate. When a wave passes through a hole, diffraction happens the most if ...

- (A) the amplitude is much larger than the hole.
- (B) the amplitude is much smaller than the hole.
- (C) both the amplitude and hole are very small.
- (D) the wavelength is much larger than the hole.
- (E) the wavelength is much smaller than the hole.
- (F) both the wavelength and hole are very small.

14) [10 pts] Two speakers and you are arranged on a straight line, with the speakers separated by 0.35m, and you 2.3m from the closest speaker. The speakers are being driven by the same electronic source, but one has been wired backwards so that they are exactly out of phase with each other. Give two frequencies for which the sound you hear from the speakers will be particularly loud. HINT: Partial credit given for a clear picture illustrating the wave relationships.