

Physics 101: The Science of Sound

Final Exam a, 12/18/06

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.

Scoring:

Raw Total: _____/122 pts

Adjusted Score: _____%

The Exam consists of 15 problems.

- 1) [6 pts] The force with which the sun pulls the planets is inversely proportional to the square of the distance from the sun to the planet. That means that when comparing planets A and B, using d for the distance from the sun and F for the force of the sun, you can properly use which equation(s)? (Circle all that are correct.)

(A) $\frac{F_A}{F_B} = \frac{d_A}{d_B}$ (B) $F_A = d_A^2$ (C) $\frac{F_A}{F_B} = \frac{d_A^2}{d_B^2}$ (D) $\frac{F_B}{F_A} = \frac{d_A^2}{d_B^2}$

(E) $\frac{F_A}{F_B} = \frac{d_A}{d_B}$ (F) $\frac{F_B}{d_B^2} = \frac{F_A}{d_A^2}$ (G) $\frac{F_A}{F_B} = \frac{1/d_A^2}{1/d_B^2}$ (H) $\frac{F_A}{F_B} = \frac{1/d_A}{1/d_B}$

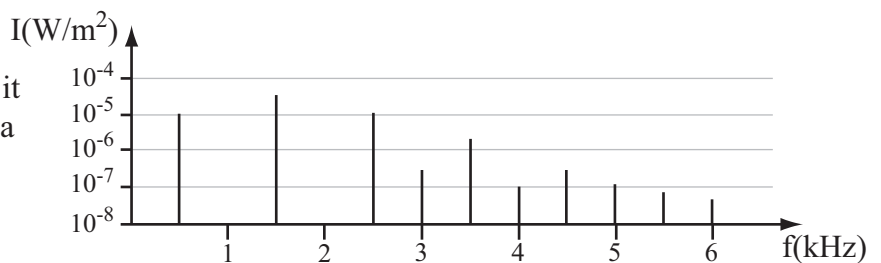
- 2) [6 pts] Which of the following are physical laws that were involved with making SHM a special kind of motion, through the circle of physics? (Circle all that apply.)

- (A) Hooke's Law (B) Ohm's Law (C) Fechner's Law (D) Newton's 2nd Law
 (E) Federal Law (F) Newton's 1st Law

- 3) [6 pts] If there is a transverse traveling wave for which you know the frequency and wave speed, which of the following other characteristics can you determine? (Circle all that apply.)

- (A) Amplitude (B) Period (C) Energy (D) Loudness
 (E) Initial Phase (F) Wavelength (G) Timbre (H) Purity

- 4) [6 pts] Under the spectrum to the right, label each peak with the numbers appropriate to describing it as a partial, as an overtone, and as a harmonic.



partials: — — — — — — —
 overtones: — — — — — — —
 harmonics: — — — — — — —

- 5) [6 pts] Sound A is 30dB more than sound B. Which of the following equations is accurate? (Circle all that are correct.)

(A) $\frac{I_A}{I_B} = 1000$ (B) $\frac{I_A}{I_B} = 30\text{dB}$ (C) $I_A - I_B = 1000$ (D) $I_A - I_B = 30\text{dB}$

(E) $\frac{L_{I,A}}{L_{I,B}} = 1000$ (F) $\frac{L_{I,A}}{L_{I,B}} = 30\text{dB}$ (G) $L_{I,A} - L_{I,B} = 1000$ (H) $L_{I,A} - L_{I,B} = 30\text{dB}$

6) [6 pts] Sally whispers something into Brenda's ear. Put the following body parts in the order that the sound passes through, from generation of the sound to detection of the sound.

List letters in order

- | | |
|-----------------|-------|
| (A) osciles | _____ |
| (B) vocal folds | _____ |
| (C) pharynx | _____ |
| (D) ear drum | _____ |
| (E) outer ear | _____ |
| (F) cochlea | _____ |
| (G) oral cavity | _____ |

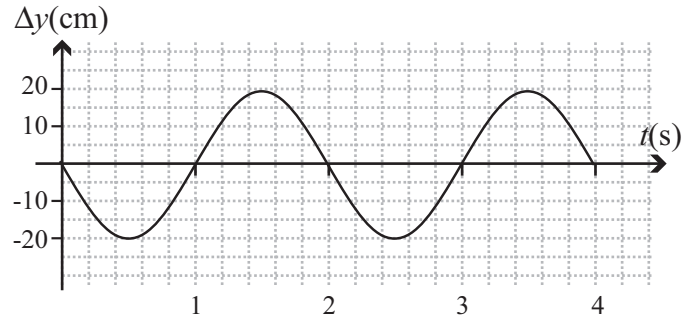
7) [10 pts] You are developing a machine to tell hockey players how fast their slapshot is. It is positioned 26.5m (that's 1/2 of a hockey rink length) from the player, who then shoots the hockey puck to the machine. The machine listens for the sound of the player hitting the hockey puck, and then senses when the hockey puck hits the machine. If the time between those events is 0.780s, how fast was the hockey puck moving? (Assume that the hockey puck has a constant speed, and use 333m/s for the speed of sound in this cold air.)

8) [8 pts] In lab, the speaker in one setup is emitting a pure tone at 274Hz, and a neighboring one is emitting a pure tone at 282Hz. Listening to both, you should expect to hear ... (circle one)

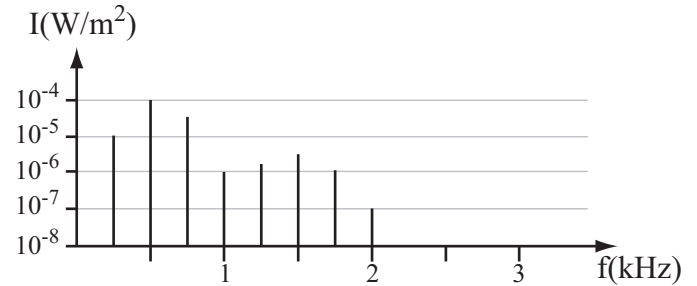
- (A) a difference tone (B) beats (C) a fusion frequency (D) warbling (E) a complex tone

with a frequency of _____ (fill in the appropriate numerical value).

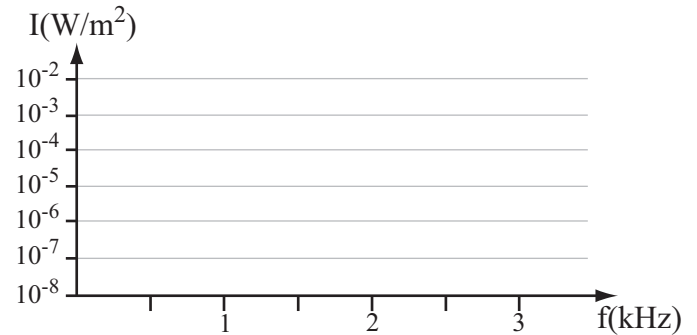
9) [10 pts] The graph to the right records the simple harmonic motion of an oscillator. Specify three quantities from which someone else could completely reconstruct the motion. For each quantity, give the name or traditional symbol, and the numerical value.



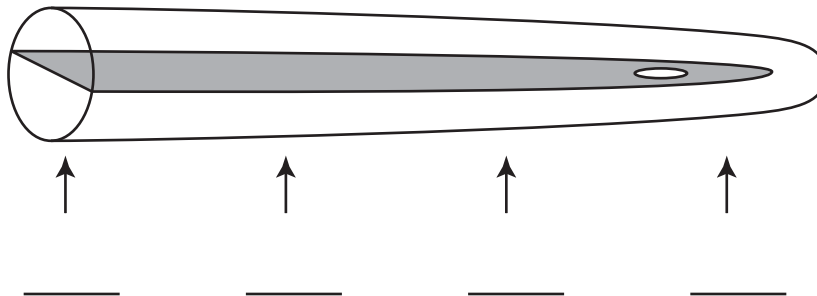
10a) [8 pts] To the right is a spectrum of some instrument playing a particular note. What is the frequency of the note it is playing?



10b) [8 pts] On the second set of axes, sketch what to expect for a spectrum when that same instrument plays a note one octave higher. Assume that the timbre and loudness of the higher note are as close as they can be to the lower note. Note that the vertical scale is logarithmic.

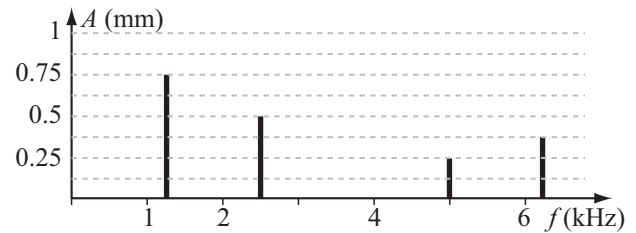


11) [8 pts] On the picture of a cochlea below, four locations are indicated by arrows. For each arrow, indicate a frequency that would excite the basilar membrane with a maximum amplitude at that location.

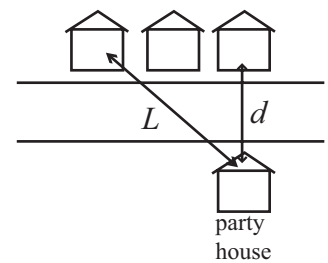


12) [10 pts] An amplitude spectrum for the motion of a vibrating surface is shown. If the resulting sound has a fundamental with a sound intensity level of 64dB, then what is the sound intensity level of the 4th harmonic? (Choose one)

- (A) 59.2 dB (B) 21.3 dB
 (C) 54.5 dB (D) 61.0 dB
 (E) 7.1 dB (F) $6.28 \times 10^{-7} \text{ W/m}^2$
 (G) $8.37 \times 10^{-7} \text{ W/m}^2$ (H) $2.79 \times 10^{-7} \text{ W/m}^2$



13) [10 pts] A raucous party on a front porch causes a sound intensity averaging $2 \times 10^{-6} \text{ W/m}^2$ at the house directly across the street. What intensity would you expect across the street and two doors down? Take L to be 1.5 times farther than d .



14) [6 pts] When listening to sounds from a distant source, the sound has a muffled quality. This is because lower frequency sounds are better at going around corners than high frequency sounds. The spectrum of the distant sound therefore has low frequencies (below about 200Hz) emphasized. The threshold to hear such low frequency sounds is _____ the threshold to hear sounds with frequencies near 1000Hz. (Choose correct phrase to fill in blank.)

- (A) higher than (B) lower than (C) about the same as

15) [8 pts] In table 15.3, Rossing says that a male voice making the “ae” sound typically has formants at frequencies of 660Hz, 1720Hz, and 2410Hz, with strengths of -1dB, -12dB, and -22dB respectively. Based on these measurements, on the axes below, sketch the vocal tract response curve for that situation.

