

Physics 101: The Science of Sound

MiniTest 3a, 11/8/06

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, or choice made in multiple choice problems.

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: _____/100 pts

Adjusted Score: _____%

Potentially useful equations

$$g = 9.81 \text{ m/s}^2$$

$$\pi = 3.1415$$

$$\Delta x = A \cos(\phi)$$

$$\Delta x = A \cos\left(\frac{360^\circ}{T}t + \phi_0\right)$$

$$v_{\text{avg,pp}} = 4 \frac{A}{T}$$

$$v_{\text{max}} = \frac{\pi}{2} v_{\text{avg,pp}}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

$$PE = \frac{1}{2} k(\Delta x)^2$$

$$KE = \frac{1}{2} m v^2$$

$$E = \frac{1}{2} k A^2$$

$$\text{whole tone ratio} = 1.12246$$

$$\text{semitone ratio} = 1.05946$$

$$L_I = (10 \text{ dB}) \log\left(\frac{I}{I_0}\right)$$

$$I = I_0 10^{(L_I/10 \text{ dB})}$$

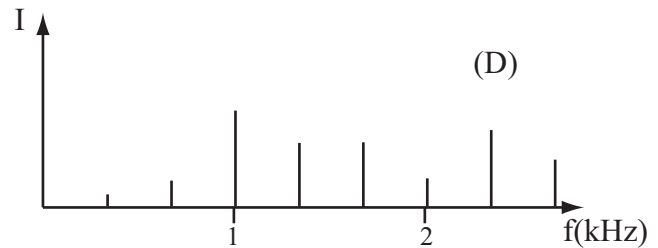
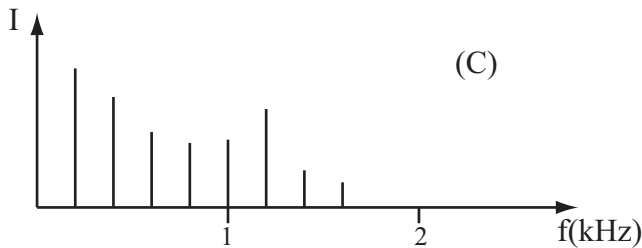
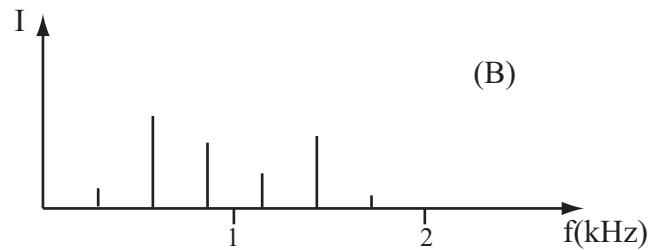
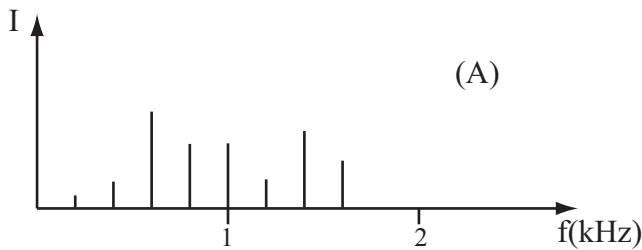
$$\Delta L_I = L_{I1} - L_{I2} = (10 \text{ dB}) \log\left(\frac{I_1}{I_2}\right)$$

$$\frac{I_1}{I_2} = 10^{(\Delta L_I/10 \text{ dB})}$$

$$A = 2\pi r^2$$

$$A = 4\pi r^2$$

1) [10 pts] Of the following sound spectra, which two will have the most similar timbre? Circle the two letter labels.



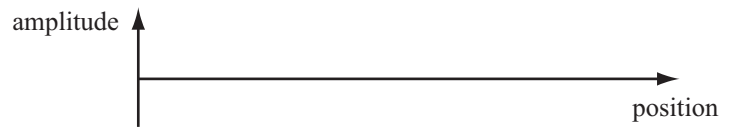
2) [15 pts] Below is a picture of the part of the ear which analyzes sounds.

(a) What is it called? _____



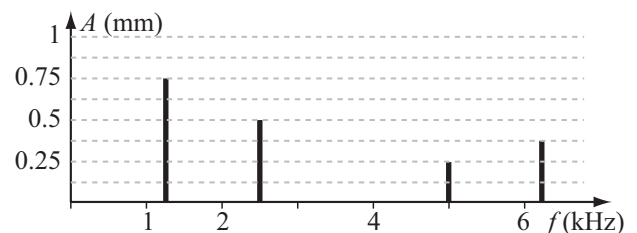
(b) What is the grey part called?

(c) Draw on the axis below it the amplitude of vibration as a function of position when the ear is listening to a pure tone of frequency 200 Hz.



3) [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) $8.37 \times 10^{-7} \text{ W/m}^2$ (B) 21.3 dB
 (C) $2.79 \times 10^{-7} \text{ W/m}^2$ (D) 7.1 dB
 (E) $6.28 \times 10^{-7} \text{ W/m}^2$ (F) 59.2 dB
 (G) 61.0 dB (H) 54.5 dB



4) [15 pts] The critical band width at 400Hz is 110Hz. How many different semitones are in that critical band? (Choose one)

- (A) 87 (B) 378 (C) 103 (D) 105 (E) 32 (F) 4 (G) 5 (H) 20

5) [20 pts] Two political candidates proclaiming victory from a podium produce a sound intensity level in your ears of 82dB. Three more join them. What SIL do you hear now? (Assume they are all the same individually.)

6) [20 pts] One of the loudest natural sounds is thunder, which can reach the human threshold of pain very close to a lightning strike (1m away, say). Treating this as a point source, at what distance would you expect the thunder's intensity to drop to 10^{-8}W/m^2 ?

7) [10 pts] Close to the lightning, thunder has a spectrum with energy at frequencies ranging from 10Hz to 5000Hz. After it travels so far through the air, the higher frequency parts of the spectrum get absorbed, leaving frequencies in the 20Hz to 100Hz range. The threshold to hear such 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