


Physics of Sound and Music 2007 Midterm II

Thursday May 24th 2007, 9:30 am.
Professor Meadows

Name

1. A string (clamped at both ends) has a fundamental frequency of f_0 (Hz) that has wavelength λ_0 . Its length is ℓ (m) and its total mass is m (kg). The speed of transverse waves along it is v ($m \cdot s^{-1}$). Then:

a) $\lambda_0 = v f_0 / 4$; b) $\lambda_0 = \ell / 2$; c) $\lambda_0 = v / \ell$; d) $\lambda_0 = \ell$; e) None. 

2. A string (clamped at both ends) has a fundamental frequency of f_0 (Hz) that has wavelength λ_0 . Its length is ℓ (m) and its total mass is m (kg). The speed of transverse waves along it is v ($m \cdot s^{-1}$) and the tension is T (N). Then suppose that $m = 5 \times 10^{-4}$ (kg), $\ell = 0.5$ (m) and $F = 160$ (N). Then:

a) $v = \sqrt{\frac{m}{\ell}}$ ($m \cdot s^{-1}$); b) $v = \sqrt{\frac{F}{\ell}}$ ($m \cdot s^{-1}$); c) $v = 400$ ($m \cdot s^{-1}$).

3. A string whose length is 45 (cm) is clamped at both ends, and has a fundamental frequency of 440 (Hz). The wavelength of the third harmonic is

a) 20 (cm); b) 30 (cm); c) 60 (cm); d) less than any of these; e) more than any of these.

4. Which of the following does *not* affect the quality of a sound:

a) Attack; b) Vibrato; c) Fourier structure; d) Speed of sound in air; e) Formant?

5. A woodwind instrument produces a sound whose fundamental frequency is 400 (Hz). Its Fourier components show that the third harmonic is actually stronger than the fundamental. A reason for this could be

a) The vibrating column of air is affected by some valve at a point half-way from one end; b) There is a formant near 1200 (Hz); c) The body of the instrument has a narrow resonance covering the range 250-350 (Hz)

6. The amplitude for the fundamental mode of a sawtooth wave signal is 3 ($N \cdot m^{-2}$) and is at a frequency of 300 Hz. The next harmonic in the

Fourier analysis of this signal has frequency:

a) 150 (Hz); **b) 600 (Hz);** c) 900 (Hz); d) 1200 (Hz);

7. The amplitude for the fundamental mode of a square wave signal is $3 (N \cdot m^{-2})$ and is at a frequency of 400 (Hz). The next harmonic in the Fourier analysis of this signal has amplitude:

a) $3 (N \cdot m^{-2})$; **b) $1 (N \cdot m^{-2})$;** c) $1/3 (N \cdot m^{-2})$ d) 1400 (Hz);

8. A sawtooth signal has fundamental mode at 100 (Hz) with amplitude $10^{-5} N \cdot m^{-2}$. The next harmonic in its Fourier decomposition recipe is at 200 (Hz) with amplitude $10^{-4} N \cdot m^{-2}$.

a) True; **b) False.**

9. The Figure represents amplitude modulation. The top graph is a signal that modulates the carrier that is illustrated in the second graph below it. The resultant signal is represented by the graph at

a) **a**; b) **b**; OR **c) c**.

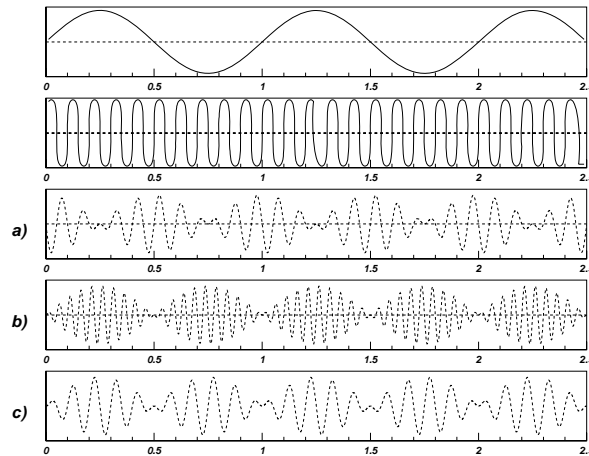


Figure 1: Question 9

10. The Figure represents amplitude modulation. The top graph is a signal that modulates the carrier that is illustrated in the second graph below it. The resultant signal is represented by the graph at
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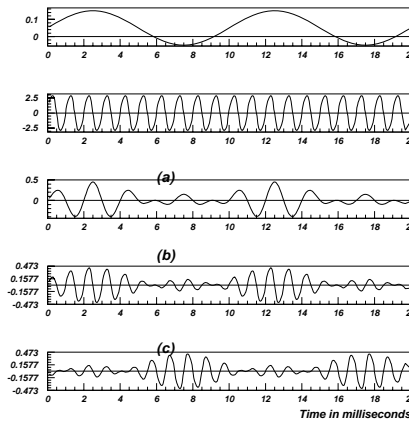


Figure 2: Question 10

11. In an analogue synthesizer, a filter is used to modify a signal from a square wave generator to make it sound more like that from a closed pipe instrument. The filter output is large for frequencies lower than 950 (Hz) and virtually eliminates them above 950 (Hz). Is this a
 a) high-pass; **b)** low-pass; c) notch; OR a d) band-pass filter?

12. “White noise” is best described as:
 a) A sound which, if passed through a high-pass filter, will sound just like a tuning fork with a single frequency. **b)** A sound like rushing air made up from equal strengths of signals at a wide range of frequencies; c) A sound with only even, not odd, harmonics.

13. A ring modulator has a sinusoidal carrier with a frequency of 800 (Hz) and a sinusoidal modulator frequency of 4 (Hz). The frequencies of two sinusoidal waves of equal amplitude that could be added to create the same effect are:
 a) 792 and 808 (Hz); b) 100 and 6400 (Hz). **c) 796 and 804 (Hz);**

14. A tuning fork produces a sound intensity level (SIL) of 32 (dB) at 3.6 (kHz). The SIL for 10 identical oscillators together is
 a) 320 (dB); b) 32 (dB); **c) 42 (dB);** d) 42 (phons).

15. Which of the following tones sounds (to the human ear) to be the loudest:
 a) SIL 40 (dB) at 100 (Hz); b) SIL 30 (dB) at 200 (Hz); c) SIL 50 (dB) at 50 (Hz); **c) 20 (phons) at any frequency?**

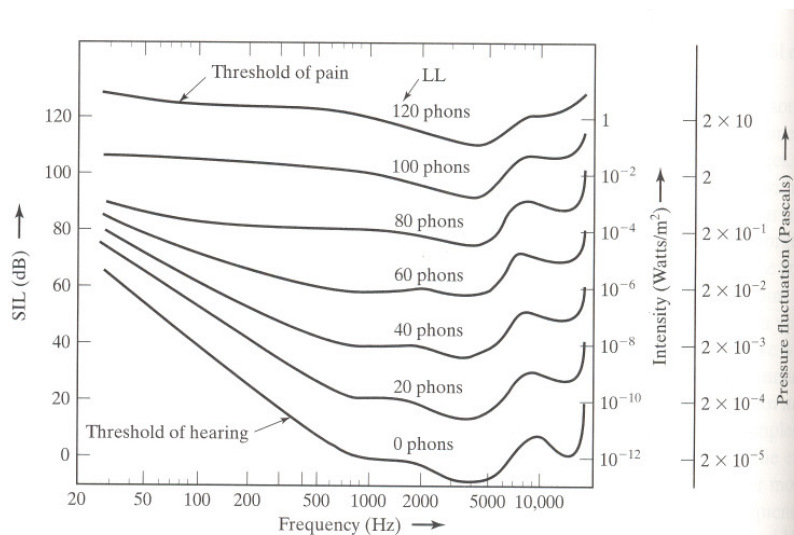


Figure 6-4 Equal loudness curves. The curve with the lowest level marks the threshold of hearing; the curve with the highest level marks the threshold of pain.

16. Which sound is at the highest SIL:
 a) 10 (phons) at 4000 (Hz); b) 10 (phons) at 200 (Hz) c) 40 (phons) at 4000 (Hz) **d) 0 (phons) at 50 (Hz).**
17. If the power in a sound wave is to be multiplied by 4 without any change in frequency, the amplitude of the pressure disturbance must be multiplied by
a) 2; b) 4; c) 8; d) 16.
18. The name given to the mechanism behind the drawing together of the two vocal folds when a person speaks is called
 a) a difference tone; **b) the Bernoulli effect;** c) fundamental tracking;
 d) binaural beating.
19. When a pure tones at 1,000 (Hz) enters a person's ear, non-linear effects produce harmonics of this tone at 2,000, 3,000 (Hz), *etc* .
a) True; b) False.
20. The column of air between a person's lips and their vocal chords acts like a column of air that is closed at one end and open at the other end. The person's first formant is centered at a frequency of 680 (Hz). The distance between their lips and their vocal chords is approximately:
 a) 50 (m); b) 50 (cm); c) 25 (cm); **d) 12.5 (cm).**
*[Speed of sound in air is **340 (m·s⁻¹).**]*
21. Two pure tones, one at 800 (Hz) and the other at 1.6 (kHz) enter a person's ear.
 a) The energy is all deposited in a single "critical zone"; **b) Most of the energy from one frequency is deposited in the basilar membrane approximately 3.5 (mm) from the energy from the other frequency;** c) Both the above are true since a critical zone is approximately 3.5 (mm) wide.

22. In order to adjust the frequency defining one of the formants in their speech, a person can adjust several things near either a node or an antinode in the column of air between their vocal flaps and the point of exit of the sound. One thing that they cannot so adjust is their:

a) lips; b) soft palate; **c) nasal cavity;** d) tongue.

23. Two pure tones, one at 800 (Hz) and the other at 600 (Hz) enter a person's ear. Non-linear effects produce harmonics of each tone that can produce a "combination (difference) tone" at 400 (Hz).

a) True; b) False.

24. A wave has a complex shape. Ohm's law of hearing states that, if the phase of any of the Fourier components is changed, then

a) The sound perceived by the ear changes; **b) The sound perceived by the ear does **not** change;** **c) The sound shape of the waveform changes;** d) The sound shape of the waveform does **not** change.



25. Which of the following is **not** part of the anatomy of the human throat and voice system:

a) pharynx; b) hard palate; **c) auditory nerve;** d) oral cavity.