Exercises

1. Two waves of amplitude A and period T and constant phase ϕ are superposed. If wave 1 travels 37 wavelengths farther than wave 2, then what is a possible value for the total phase difference?

I. 2π.
II. $\pi/4$.
III. $\pi/2$.
IV. π.
V. $3\pi/2$.

2. Two waves of amplitude A and period T are superposed. The difference of their constant phases is p (i.e.. $\Delta\phi = \phi_1 - \phi_2 = \pi$). If wave 1 travels 13.5 wavelengths farther than wave 2, then what is a possible value for the total phase difference?

I. 2π.
II. $\pi/4$.
III. $\pi/2$.
IV. π.
V. $3\pi/2$.

3.Which of the following are possible differences that can create beats?

I. path length difference; Δx.
II. amplitude difference; ΔA.
III. frequency difference; Δf.
IV. equilibrium offset difference; ΔB.
V. constant phase angle difference; Δf.

4. Two stretched strings are placed next to one another. One has a length of 1.5 m and the other has a length of 1.55 m. Both of the strings have their ends fixed. Both are then pulled in order to make sound such that exactly one anti-node appears in the middle. If the speed of the traveling waves on each string is 100 m/s, what is the beat frequency created by the superposition of the sounds produced by each string?

5. Two sound waves of identical amplitude are simultaneously present in a room. If the frequencies of these sounds are 300 Hz and 310 Hz, describe precisely what you hear, and at what frequency.

6. How would you explain to your musician friend (who is not taking physics) why she sometimes hears a wobbling sound (*i.e.*, beats) when she attempts to play the same note simultaneously on two separate strings?

7. Which of the following total phase difference values of will give you completely constructive interference?

I. 0.
II. $\pi/2$.
III. π.
IV. $3\pi/2$.
V. 2π.

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I. 0.
II. $\pi/2$.
III. π.
IV. $3\pi/2$.
V. 2π.

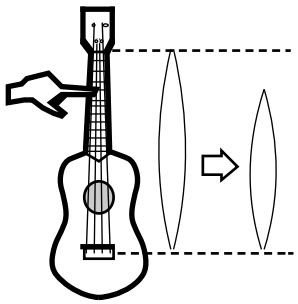
9. Determine the angles at which the first three maxima will be found for light of wavelength 520 nm impinging on a diffraction grating with a slit spacing of 0.12 mm.

10. Which of the following are possible differences that can contribute to the difference in total phase angle, $\Delta\Phi$?

I. path length difference; Δx.
II. amplitude difference; ΔA.
III. frequency difference; Δf.
IV. equilibrium offset difference; ΔB.
V. constant phase angle difference; Δf.

11. Explain whether a string that is vibrating at a certain standing wave frequency (say, 500 Hz) produces a sound wave of exactly the same frequency or not.

12. The strings on a ukulele vibrate at their fundamental frequency. Different notes can be played on a given ukulele string by placing a finger somewhere between the ends of the string. Explain why the frequencies of these "fingered" notes must be higher than the frequency of the untouched string.



13. Two waves of amplitude A and period T are superposed. If they completely constructively interfere, what is the new amplitude that these two waves will add to?

I. 0.
II. $0.5A$.
III. A.
IV. $2A$.
V. $4A$.

14. Two waves of amplitude A and period T are superposed. If they completely destructively interfere, what is the new amplitude that these two waves will add to?

I. 0.
II. $0.5A$.
III. A.
IV. $2A$.
V. $4A$.

15. If θ (in radians) is small ($< \pi/8$), then θ will approximately be:

I. $\sin\theta$
II. $\cos\theta$
III. $\tan\theta$
IV. both (I) and (II).
V. both (I) and (III).

16. A nylon string is stretched between supports 1.4 m apart. Given that the speed of a transverse wave along this string is 500 m/s, what frequency will give you standing waves with one node (where the string is hooked on the ends is not considered a node)?

17. A nylon string is stretched between supports 1.8 m apart. Given that the speed of a transverse wave in the string is 100 m/s, what frequency will give you standing waves without any nodes (where the string is hooked on the ends is not considered a node)?

18. What will happen to the constant phase of a transverse wave in a low impedance medium when it reflects off of a higher impedance medium?

19. What will happen to the constant phase of a transverse wave in a high impedance medium when it reflects off of a lower impedance medium?

20. If there was no constant phase angle difference between two waves of the same frequency, then which of the following path length differences would lead to completely constructive interference?

I. $\Delta x = 0$.
II. $\Delta x = 0.5\lambda$.
III. $\Delta x = \lambda$
IV. $\Delta x = 1.5\lambda$.
V. $\Delta x = 2\lambda$.

Exercise Solutions

1. The correct answer is (I).

2. The correct answer is (I).

3. The correct answer is (III).

4. Since there isn't a node, this means that the entire length (1.5 m and 1.55 m) will constitute a half of a wavelength. For the shorter string, this will give a frequency of 33.3 Hz. For the longer string, this will give a frequency of 32.2 Hz. The beat frequency will be the difference of these two frequencies and will thus be 1.1 Hz.

5. You should hear beats, as you are superposing two waves of different frequencies. The frequency you will hear will be an average of the two, 305 Hz. Can you get beats if these two waves are of different amplitudes?

6. Be very descriptive here in your own words of the superposition process of adding two waves that create a beat-modulated sound.

7. The correct answers are (I) and (V).

8. The correct answer is (III).

9. Recall that the angle q = 0¡ is always a maxima *for sources in phase with each other,* so that's one maxima location. To find the other maxima angles, invert $m\lambda = d\sin\theta$ to solve for θ with m=1 and m=2. These two angles will be 0.248° for m=1 and 0.497° for m =2.

10. The correct answers are (I), (III), and (V).

11. It had better. The string is the source, and if it is vibrating at a frequency of 500 Hz, then it determines the frequency of the sound wave it produces. The frequency does not change as the wave changes medium from string to air.

12. Note that since we do not change any of the properties of the ukulele string (tension and linear mass density), the wave velocity v_{wave} through this string remains constant no matter how and where we place our finger. For a string fixed at both ends, a decrease in L means increase in the fundamental frequency f_1.

13. The correct answer is (IV).

14. The correct answer is (I).

15. The correct answer is (V).

16. Since there is only one node, this means that the entire length (1.4m) will constitute one wavelength. Thus, we can use $v=\lambda f$ to find, f=357Hz.

17. Since there isn't a node, this means that the entire length (1.8 m) will constitute a half of a wavelength. Thus, we can use $v=\lambda f$ to find, f=27.8Hz.

18. It will experience a sudden shift of $\Delta\pi$ to its constant phase.

19. It will experience no shift to its constant phase.

20. The correct answers are (I), (III), and (V).