Welcome back, Bill Wiecking

>>Working in AP Physics B (SC651)

ch 18 superposition

superposition, interference

Chapter 18: Wave Superposition and Interference

Conceptual problems

18.C.1 **(10.00)** A guitar designer is trying out a string of mass per unit length μ. In order to have a fundamental frequency of f_o, the required tension in this string is F_T. However, she finds that when this tension is applied, this string snaps under the applied stress. Will using a string made of the same material, only thicker, solve her design problem? Explain your answer.

○ Yes ○ No

Section 0: Introduction

18.0.1 **(5.00)** Use the simulation in the first interactive problem in Section 18.0 to create a situation where the pulses will exactly cancel each other out. (a) If the left pulse is a peak, what should the right pulse be? (b) If the amplitude of the left pulse is 2.00 m, what should the amplitude of the right pulse be? (c) If the width of the left pulse is 1.00 m, what should the width of the right pulse be?

(a) ○ Peak ○ Trough
(b) ____ m
(c) ____ m

Section 3: Standing wave equations

18.3.1 **(5.00)** A standing wave in a string is described by the equation

$y_s = (5.0\times10^{-4})\sin(4.8\times10^{-3}x)\cos(1400t)$ meters

What is the x position (a) of the 0^{th} antinode? (b) of the 3^{rd} node?

(a) ____ m

(b) m

18.3.2 **(5.00)** The 4th node of a standing wave occurs at a position of *x4* meters. Where is the 2nd antinode?

m

18.3.3 **(7.00)** A string with a linear mass density of 0.0150 kg/m and length of 0.750 m is fixed at both ends with a tension of 45.0 N. If you wish to start a standing wave in the string with 6 nodes (including the nodes at the fixed ends), what is the (a) angular wave number and (b) the angular frequency that you will use? Hint: With 6 nodes, the last node corresponds to n = 5.

(a) rad/m
(b) rad/s

Section 5: Interactive problem: match a standing wave

18.5.1 **(5.00)** Use the information given in the interactive problem in Section 18.5 to calculate (a) the amplitude and (b) the angular wave number of the wave traveling from left to right. Test your answer using the simulation.

(a) m
(b) rad/m

Section 7: Harmonics

18.7.1 **(5.00)** What is the fundamental frequency of a 4.65×10^{-3} kg, 2.50-meter string under 438 newtons of tension?

Hz

18.7.2 **(5.00)** A string that is under a tension of 389 N has a linear mass density of 0.0220 kg/m. Its fundamental frequency is 440 Hz (an A note). How long is the string?

m

18.7.4 **(7.00)** You drape a string over a pulley and hang a mass of 35.0 kg from one end. You tie the other end to a point a distance L from the pulley so that the string is horizontal between this point and the pulley. The string has a linear mass density of 0.0470 kg/m. If you want the difference in frequency between any two consecutive harmonics to be 35.0 Hz, what will the distance L have to be?

m

Section 8: Interactive problem: tune the string

18.8.1 Use the information given in the interactive problem in Section 18.8 to

(5.00) calculate (a) the string length and (b) the harmonic required to play a G note. Test your answer using the simulation.

(a) ______ m

(b) ______

Section 10: Music from wind instruments

18.10.1 **(5.00)** A 2.1-meter pipe is open at both ends. What is its fundamental frequency? (Use 343 m/s for the speed of sound.)

______ Hz

18.10.2 **(5.00)** A pipe with one closed end has a fundamental frequency of 262 Hz at 42.8°C. How long is the pipe?

______ m

Section 14: Wave interference and path length

18.14.2 **(7.00)** Speaker 1 is positioned at the origin and speaker 2 is at the position (0, 4.00) meters. They emit identical sound waves of wavelength 1.55 m, in phase. If you stand on the x axis at (x, 0) meters, what is the smallest positive value for x for which you experience complete destructive interference?

______ m

18.14.3 **(7.00)** Two speakers emit sound of identical frequency and amplitude, in phase with each other. The frequency is 415 Hz. If the speakers are 9.00 meters apart, and you stand on the line directly between them, 3.47 m from one speaker, are you standing closer to a point of constructive or destructive interference? (Use 343 m/s for the speed of sound.)

- Constructive
- Destructive

Section 17: Beats

18.17.1 **(5.00)** Two violinists are playing their "A" strings. Each is perfectly tuned at 440 Hz and under 245 N of tension. If one violinist turns her peg to tighten her A string to 251 N of tension, what beat frequency will result? Express your answer to the nearest 100^{th} of a Hz.

______ Hz

18.17.2 **(5.00)** Two identical strings are sounding the same fundamental tone of frequency 156 Hz. Each string is under F N of tension. The peg holding one string suddenly slips, reducing its tension slightly, and the two tones now create a beat frequency of three beats per second. What is the new tension in the string that slipped?

N

18.17.4 **(5.00)** Consider the musical note "A above middle C", known as "concert pitch" or "A440." The frequency of this note is 440 Hz by international agreement. In the chromatic scale, the frequency of a sharp is a factor of 25/24 higher than the note, and the frequency of a flat is a factor of 24/25 lower. If the "A sharp" and the "A flat" notes corresponding to A440 are played together, what will be the resulting beat frequency? (State your answer to the nearest Hz.)

Hz

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