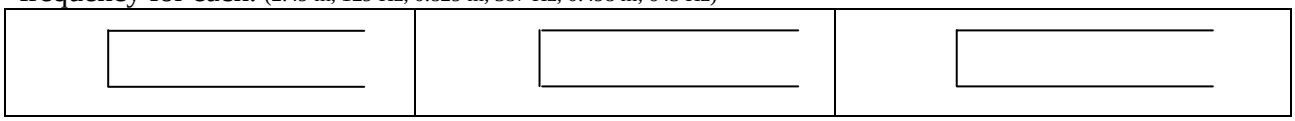
Standing Waves from 12.1

A1. A Pan pipe is 62.2 cm long, and has a wave speed of 321 m/s. It is a one end open, one end fixed pipe.

a. Draw the first three harmonics of vibration on the pipe below, and calculate the wavelength and frequency for each. (2.49 m, 129 Hz, 0.829 m, 387 Hz, 0.498 m, 645 Hz)

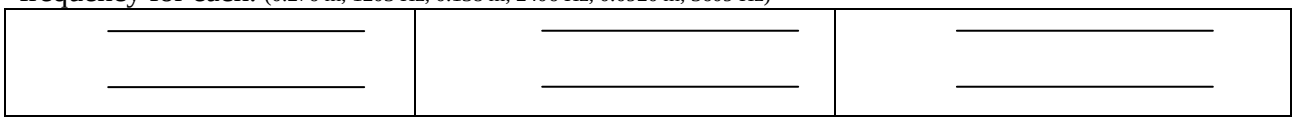


b. If the air in the pipe were heated, and the wave speed changed to 351 m/s, what would be the new fundamental frequency of the pipe? (141 Hz)

c. If I cut 12.1 cm from the open end of this pipe (The pipe is shortened by this much) what is the new fundamental frequency? (use v = 321 m/s) (160. Hz)

A2. A Pennywhistle is 13.8 cm long, and has wave speed of 332 m/s. It is a both ends open pipe.

a. Draw the first three harmonics of vibration on the pipe below, and calculate the wavelength and frequency for each. (0.276 m, 1203 Hz, 0.138 m, 2406 Hz, 0.0920 m, 3609 Hz)

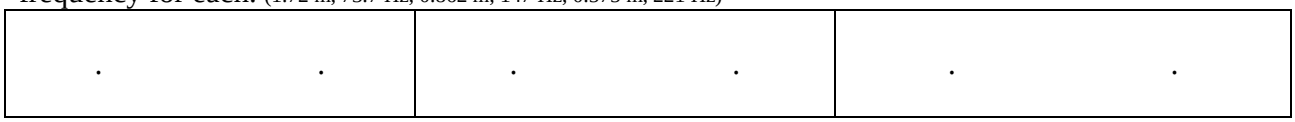


b. If the air in the pipe were cooled to make the wave speed 295 m/s, what would be the new fundamental frequency? (1069 Hz)

c. If I lift a finger off the whistle 1.8 cm from the end (The pipe is shortened by this much) what is the new fundamental frequency? (1383 Hz)

A3. A bass string has a length of 86.2 cm, and a wave speed of 127 m/s.

a. Draw the first three harmonics of vibration on the string below, and calculate the wavelength and frequency for each. (1.72 m, 73.7 Hz, 0.862 m, 147 Hz, 0.575 m, 221 Hz)

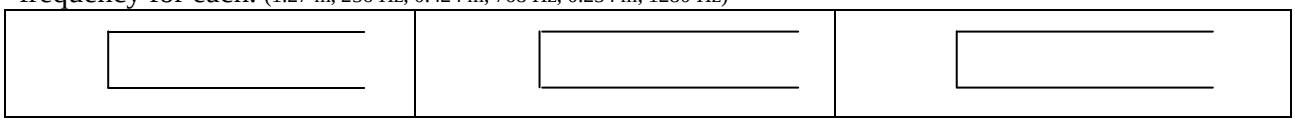


b. What would be the new fundamental (lowest) frequency if the string were tightened, making the wave speed 145 m/s? (84.1 Hz)

c. If this string is fingered 8.5 cm from one end (it is shortened by that amount). What is the frequency of the fundamental now? (use 127 m/s as the speed) (81.7 Hz)

A4. A Panpipe is 31.8 cm long, and has a fundamental frequency of 256 Hz. It is a one end open, one end fixed pipe.

a. Draw the first three harmonics of vibration on the pipe below, and calculate the wavelength and frequency for each. (1.27 m, 256 Hz, 0.424 m, 768 Hz, 0.254 m, 1280 Hz)

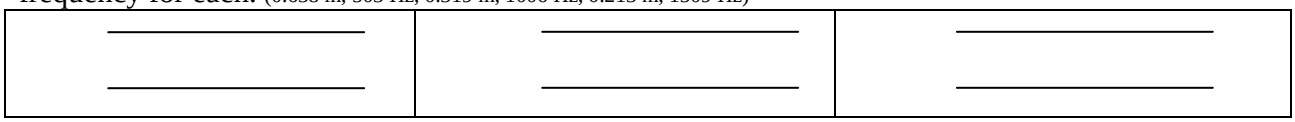


b. What is the velocity of the sound in this pipe? (326 m/s)

c. If I cut 3.2 cm from the open end of this pipe (The pipe is shortened by this much) what is the new fundamental frequency? (285 Hz)

A5. A Pennywhistle is 31.9 cm long, and has a fundamental frequency of 503 Hz. It is a both ends open pipe.

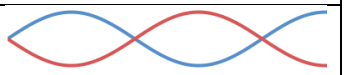
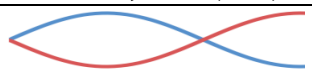
a. Draw the first three harmonics of vibration on the pipe below, and calculate the wavelength and frequency for each. (0.638 m, 503 Hz, 0.319 m, 1006 Hz, 0.213 m, 1509 Hz)



b. What is the velocity of the sound in this pipe? (321 m/s)

c. If I lift a finger off the whistle 4.7 cm from the end (The pipe is shortened by this much) what is the new fundamental frequency? (590. Hz)

Calculate the missing quantity below. L is the length of the waveform (the picture), λ is the wavelength.

	a	b	c	d
B1	 L = 193 cm, λ = ? (386 cm)	 L = 5.76 m, λ = ? (23.0 m)	 λ = 24.0 cm, L = ? (36.0 cm)	 λ = 65.0 cm, L = ? (81.3 cm)
B2	 L = 215 cm, λ = ? (215 cm)	 L = 4.32 m, λ = ? (5.76 m)	 λ = 24.0 cm, L = ? (24.0 cm)	 λ = 2.70 m, L = ? (4.05 m)
B3	 L = 73.0 cm, λ = ? (58.4 cm)	 L = 3.82 m, λ = ? (2.55 m)	 λ = 93.5 cm, L = ? (187 cm)	 λ = 2.40 m, L = ? (2.40 m)
B4	 L = 16.1 cm, λ = ? (9.20 cm)	 L = 3.45 m, λ = ? (1.725 m)	 λ = 183 cm, L = ? (91.5 cm)	 λ = 1.80 m, L = ? (1.35 m)
B5	 L = 32.5 cm, λ = ? (14.4 cm)	 L = 5.31 m, λ = ? (2.12 m)	 λ = 63.0 cm, L = ? (158 cm)	 λ = 72.0 cm, L = ? (108 cm)

Random Standing Waves Problems

C1. Draw the third harmonic (The third lowest tone it can make.) of a both ends open pipe. If the speed of sound is 323 m/s, and the pipe is 57.5 cm long, what is the frequency of this harmonic? (843 Hz)

C2. Draw the first harmonic (The lowest tone it can make.) of a tightly stretched string. If the string is 29.8 cm long, and the frequency of this harmonic is 322 Hz, what is the wave speed on the string? (192 m/s)

C3. Draw the third possible harmonic (The third lowest tone it can make.) of a one end fixed, one end open pipe. If the pipe is 34.1 cm long, and this harmonic has a frequency of 1092 Hz, what is the speed of sound in the pipe? (298 m/s)

C4. Draw the first harmonic (The lowest tone it can make.) of a both ends open pipe. If the speed of sound is 310. m/s, and the pipe is 42.1 cm long, what is the frequency of this harmonic? (368 Hz)

C5. Draw the third harmonic (The third lowest tone it can make.) a guitar string. If this harmonic has a frequency of 864 Hz, and the string is 68 cm long, what is the speed of the waves in the string? (392 m/s)

C6. What is the fifth harmonic (The fifth lowest tone it can make) of a 45.0 cm long panpipe? (one end fixed) if the fundamental is 180. Hz? (1620 Hz)

C7. A pennywhistle is a both ends open pipe. If the standing wave in the pipe is 17 cm long, what is the wavelength and frequency of the fundamental mode of vibration, and what is the frequency of the next two modes of vibration? (Use 343 m/s as the wavespeed) (0.34 m 1008.8 Hz 2017.6 Hz 3026.5 Hz)

C8. A violin has a 33 cm long string, and is tuned to A 440 Hz. (The fundamental frequency is 440 Hz, and it is a both ends fixed standing wave) What is the wavelength of the fundamental? What is the speed of waves along the string? What are the next two frequencies possible? (0.66 m 290.4 m/s 880 Hz 1320 Hz)

C9. An organ pipe is being designed to make a fundamental tone of 64 Hz. If the speed of sound is 320 m/s inside the pipe, and the pipe is a one end open and one end closed pipe, what length should it be? What are the next two frequencies it can make? (1.25 m 192 Hz 320 Hz)

C10. A horn is a both ends open pipe. If the third harmonic has a frequency of 698 Hz, and sound has a speed of 295 m/s inside the pipe, what is the wavelength of the sound in the horn, and what is the length of the standing wave in the horn? What is the next higher frequency it can generate? (0.423 m 0.634 m 930.7 Hz)

C11. A guitar has a wave speed of 485 m/s in its string, and a string length of 65 cm. What is the frequency of the fourth harmonic on this string? (1490 Hz)

C12. What length should a panpipe be (one end open, one end closed) if it is to create a fundamental tone of 261 Hz (middle C)? Use 343 m/s as the speed of sound in the pipe. What is the frequency of the third harmonic? (0.329 m, 1305 Hz)