

14-1A) Which one of the following statements is WRONG?

- (a) A fluid can transmit only longitudinal sound waves, whereas a solid can transmit both longitudinal and transverse sound waves.
- (b) The speed of sound is much slower than the speed of light.
- (c) The speed of sound in air is closely the same for all wavelengths.
- (d) Both light and sound can travel through a perfect vacuum.
- (e) The range of frequencies for normal human hearing is about 20 Hz to 20,000 Hz.

14-2A) Which one of the following statements is WRONG?

- (a) The term ultrasound is used to describe sound waves with frequencies greater than about 20 kHz.
- (b) In a longitudinal wave, the particles move back and forth perpendicular to the direction in which the wave is traveling.
- (c) Ultrasound waves have wavelengths in matter short enough that they can be used to image organs within the human body.
- (d) Under the right conditions, high intensity ultrasound waves can be used to break up tumors.
- (e) The physics underlying ultrasonic imaging is that ultrasonic waves are partially reflected from a boundary between two materials with differing densities.

14-3A) A sound pulse is sent down a 0.5 m length of a liquid, reflected from the bottom of the container, and detected when it returns to the top of the liquid. For a round trip of 1 ms, about what is the speed of sound in the liquid?

- (a) 500 m/s (b) 1000 m/s (c) 340 m/s (d) 2000 m/s (e) None of these.

14-4A) Light travels in vacuum and air at a speed of about 3×10^8 m/s. Sound travels in air at a speed of about 345 m/sec.

If a lightning bolt that strikes 7 km (a little over 4 miles) away from you produces both a flash and a thunder clap, about how long after the flash do you hear the thunder?

- (a) 60 sec (b) 2 sec (c) 40 sec (d) 20 sec (e) You don't have enough information to tell.

14-5A) A person sitting 10 m from a point source of sound hears sound intensity I_0 . Assuming no reflections and no absorption, about what intensity should be heard by a person sitting 20 m from the point source?

- (a) I_0 (b) $I_0/2$ (c) $I_0/4$ (d) $2I_0$ (e) $4I_0$

14-6A) If you make the intensity of a sound wave 1000 times larger, you increase the sound level by about

- (a) 20 dB (b) 30 dB (c) 1000 dB (d) 3 dB (e) You can't tell without knowing the absolute magnitude of the sound intensity.

14-7A) The siren of an ambulance moving East at 35 m/s is emitting sound of frequency 500 Hz. About what frequency should be heard by a cyclist in front of the ambulance and moving West at 17 m/s? Take the velocity of sound to be 345 m/s.

- (a) 585 Hz (b) 550 Hz (c) 530 Hz (d) 430 Hz (e) 470 Hz

14-8A) If an ambulance siren is emitting sound of frequency 500 Hz, about what is the difference, $\Delta f = f_1 - f_2$, between the frequencies you should hear when the ambulance is coming toward you at 35 m/s (f_1) and going away from you (f_2) at the same speed? Assume that you are at rest and take the velocity of sound to be 345 m/s.

- (a) 0 Hz (b) 50 Hz (c) 75 Hz (d) 100 Hz (e) None of these is close.

14-9A) Which one of the following statements is WRONG?

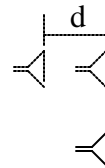
- (a) Increasing the intensity of a sound wave 100 times increases the sound level by 20 dB.
- (b) In the Doppler effect, the frequency heard increases if the source moves toward the detector.
- (c) Resonance occurs when the frequency of the driving force equals one of the natural vibration frequencies of the system.
- (d) The pitch of a pure tone is determined by its frequency.
- (e) Sound in air is a transverse wave.

14-10A) A SST is flying at Mach 2—twice the speed of sound. About what should be the angle of its shock wave?

- (a) 60° (b) 38° (c) 45° (d) 52° (e) 30°

14-11A) Two identical speakers are initially equal distances from a listener as shown at the right, and the listener hears a sound maximum (constructive interference). When the upper speaker is moved back by a distance $d = 2$ m, the listener hears a sound minimum (destructive interference). About what is the longest wavelength the sound could have?

- (a) 2 m (b) 1 m (c) 4 m (d) 0.5 m (e) 8 m

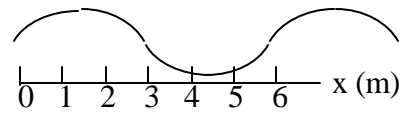


14-12A) A string of length $L = 2$ m, with both ends fixed, vibrates at a frequency of 30 Hz in its fundamental mode. About what should be the speed of a wave on this string?

- (a) 120 m/s (b) 30 m/s (c) 60 m/s (d) 15 m/s (e) None of these is close.

14-13A) A standing wave is shown at the right. About what is its wavelength?

- (a) 3 m (b) 4.5 m (c) 6 m (d) 7.5 m (e) 1.5 m



14-14A) About what is the first harmonic wavelength of a 3.0 m long half-open organ pipe?

- (a) 4.0 m (b) 1.5 m (c) 3.0 m (d) 6.0 m (e) 12 m

14-15A) A pipe of length $L = 2$ m is open at both ends. If the speed of sound in air is about 340 m/s, than about what should be the first harmonic frequency of this organ pipe.?

- (a) 85 Hz (b) 128 Hz (c) 170 Hz (d) 680 Hz (e) 43 Hz

14-16A) A violinist tunes her violin against a note struck on a piano. If the frequency of the piano note is 440 Hz and she hears 2 beats/sec against her violin string, which one of the following frequencies could be that of her violin string?

- (a) 441 Hz (b) 438 Hz (c) 440 Hz (d) 439 Hz (e) 444 Hz

14-17A) Which one of the following statements is WRONG?

- (a) The reference intensity for sound could be chosen so that very weak sounds would have negative sound levels in decibels.
(b) Tone quality is determined by the relative amounts of different harmonics in the sound.
(c) If two waves, differing only in amplitude, travel in opposite directions through a medium, they cannot produce a true standing wave.
(d) When waves interfere, there is a loss of total energy.
(e) Due to the Doppler effect, you will hear higher pitch from a given sound source when the source is moving toward you then when the source is at rest.

14-1B) Which one of the following statements is WRONG?

- (a) Both fluids and solids can transmit both longitudinal and transverse sound waves.
- (b) The speed of sound is much slower than the speed of light.
- (c) The speed of sound in air is closely the same for all wavelengths.
- (d) Light can travel through a perfect vacuum, but sound cannot.
- (e) The range of frequencies for normal human hearing is about 20 Hz to 20,000 Hz.

14-2B) Which one of the following statements is WRONG?

- (a) The term ultrasound is used to describe sound waves with frequencies greater than about 20 kHz.
- (b) In a longitudinal wave, the particles move back and forth along the direction in which the wave is traveling.
- (c) Ultrasound waves have wavelengths in matter too long to use to image organs within the human body.
- (d) Under the right conditions, high intensity ultrasound waves can be used to break up tumors.
- (e) The physics underlying ultrasonic imaging is that ultrasonic waves are partially reflected from a boundary between two materials with differing densities.

14-3B) A sound pulse is sent down a 1 m length of a liquid, reflected from the bottom of the container, and detected when it returns to the top of the liquid. For a round trip of 1 ms, about what is the speed of sound in the liquid?

- (a) 500 m/s (b) 1000 m/s (c) 340 m/s (d) 2000 m/s (e) None of these.

14-4B) Light travels in vacuum and air at a speed of about 3×10^8 m/s. Sound travels in air at a speed of about 345 m/sec. If you hear a thunder clap about 9 seconds after you see a related lightning flash, about how far from you did the lightning strike?

- (a) 3 km (b) 6 km (c) 0.3 km (d) 10 km (e) You don't have enough information to tell.

14-5B) A person sitting 20 m from a point source of sound hears sound intensity I_0 . Assuming no reflections and no absorption, about what intensity should be heard by a person sitting 10 m from the point source?

- (a) I_0 (b) $I_0/2$ (c) $I_0/4$ (d) $2I_0$ (e) $4I_0$

14-6B) If you make the intensity of a sound wave 10 times smaller, you decrease the sound level by about

- (a) 20 dB (b) 30 dB (c) 3 dB (d) 10 dB (e) You can't tell without knowing the absolute magnitude of the sound intensity.

14-7B) The siren of an ambulance moving East at 35 m/s is emitting sound of frequency 500 Hz. About what frequency should be heard by a cyclist ahead of the ambulance and moving East at 17 m/s? Take the velocity of sound to be 345 m/s.

- (a) 585 Hz (b) 550 Hz (c) 530 Hz (d) 430 Hz (e) 470 Hz

14-8B) At rest, a car's horn sounds a note of frequency 435 Hz (near A = 440 Hz). The horn is sounded while the car is moving at speed v . A bicyclist moving in the same direction as the car with one third of the car's speed hears a frequency of 415 Hz. About what is the speed of the car? Take the velocity of sound to be 345 m/s. [Point to ponder: is the cyclist ahead of or behind the car?].

- (a) 20 m/s (b) 15 m/s (c) 25 m/s (d) 22 m/s (e) 18 m/s

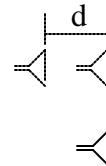
14-9B) Which one of the following statements is WRONG?

- (a) Increasing the intensity of a sound wave 100 times increases the sound level by 20 dB.
- (b) In the Doppler effect, the frequency heard decreases if the source moves toward the detector.
- (c) Resonance occurs when the frequency of the driving force equals one of the natural vibration frequencies of the system.
- (d) The pitch of a pure tone is determined by its frequency.
- (e) Sound in air is a longitudinal wave.

14-10B) A SST is flying at Mach 1.67—1.67 times the speed of sound. About what should be the angle of its shock wave?

- (a) 60° (b) 37° (c) 45° (d) 53° (e) 30°

14-11B) Two identical speakers are initially equal distances from a listener as shown at the right, and the listener hears a sound maximum. (constructive interference). When the upper speaker is moved back by a distance $d = 2$ m, the listener again hears a sound maximum. About what is the longest wavelength the sound could have?



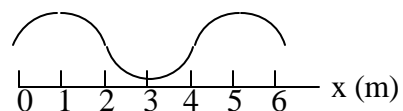
- (a) 8 m (b) 1 m (c) 4 m (d) 0.5 m (e) 2 m

14-12B) A string of length $L = 2$ m, with both ends fixed, vibrates at a frequency of 30 Hz in its second harmonic. About what should be the speed of a wave on this string?

- (a) 60 m/s (b) 30 m/s (c) 120 m/s (d) 15 m/s (e) None of these is close.

14-13B) A standing wave is shown at the right. About what is its wavelength?

- (a) 1 m (b) 2 m (c) 6 m (d) 4 m (e) 3 m



14-14B) About what is the third harmonic wavelength of a 3.0 m long half-open organ pipe?

- (a) 1.5 m (b) 4.0 m (c) 3.0 m (d) 6.0 m (e) 12 m

14-15B) A pipe of length $L = 2$ m is open at both ends. If the speed of sound in air is about 340 m/s, than about what should be the second harmonic frequency of this organ pipe.?

- (a) 170 Hz (b) 128 Hz (c) 85 Hz (d) 680 Hz (e) 43 Hz

14-16B) A violinist tunes her violin against a note struck on a piano. If the frequency of the piano note is 440 Hz she hears 2 beats/sec against her violin string. If when she tightens the string the number of beats goes up, which one of the following frequencies could be that of her initial violin string?

- (a) 441 Hz (b) 438 Hz (c) 440 Hz (d) 439 Hz (e) 442 Hz

14-17B) Which one of the following statements is WRONG?

- (a) The reference intensity for sound could be chosen so that very weak sounds would have negative sound levels in decibels.
(b) Tone quality is determined by the relative amounts of different harmonics in the sound.
(c) If two waves, differing only in amplitude, travel in opposite directions through a medium, they can produce a true standing wave.
(d) When waves interfere, total energy should be conserved.
(e) Due to the Doppler effect, you will hear higher pitch from a given sound source when the source is moving toward you than when the source is at rest.

14-1A) d 2A) b 3A) b 4A) d 5A) c 6A) b 7A) a 8A) d 9A) e 10A) e 11A) c 12A) a 13A) c 14A) e 15A) a 16A) b 17A) d

14-1B) a 2B) c 3B) d 4B) a 5B) e 6B) d 7B) c 8B) c 9B) b 10B) b 11B) e 12B) a 13B) d 14B) b 15B) a 16B) e 17B) c