

Chapter 17: WAVES — II

1. The speed of a sound wave is determined by:
 - A. its amplitude
 - B. its intensity
 - C. its pitch
 - D. number of harmonics present
 - E. the transmitting mediumans: E
2. Take the speed of sound to be 340 m/s. A thunder clap is heard about 3 s after the lightning is seen. The source of both light and sound is:
 - A. moving overhead faster than the speed of sound
 - B. emitting a much higher frequency than is heard
 - C. emitting a much lower frequency than is heard
 - D. about 1000 m away
 - E. much more than 1000 m awayans: D
3. A sound wave has a wavelength of 3.0 m. The distance from a compression center to the adjacent rarefaction center is:
 - A. 0.75 m
 - B. 1.5 m
 - C. 3.0 m
 - D. need to know wave speed
 - E. need to know frequencyans: B
4. A fire whistle emits a tone of 170 Hz. Take the speed of sound in air to be 340 m/s. The wavelength of this sound is about:
 - A. 0.5 m
 - B. 1.0 m
 - C. 2.0 m
 - D. 3.0 m
 - E. 340 mans: C
5. During a time interval of exactly one period of vibration of a tuning fork, the emitted sound travels a distance:
 - A. equal to the length of the tuning fork
 - B. equal to twice the length of the tuning fork
 - C. of about 330 m
 - D. which decreases with time
 - E. of one wavelength in airans: E

6. At points in a sound wave where the gas is maximally compressed, the pressure
- A. is a maximum
 - B. is a minimum
 - C. is equal to the ambient value
 - D. is greater than the ambient value but less than the maximum
 - E. is less than the ambient value but greater than the minimum

ans: A

7. You are listening to an “A” note played on a violin string. Let the subscript “s” refer to the violin string and “a” refer to the air. Then:
- A. $f_s = f_a$ but $\lambda_s \neq \lambda_a$
 - B. $f_s = f_a$ and $\lambda_s = \lambda_a$
 - C. $\lambda_s = \lambda_a$ but $f_s \neq f_a$
 - D. $\lambda_s \neq \lambda_a$ and $f_s \neq f_a$
 - E. linear density of string = volume density of air

ans: A

8. “Beats” in sound refer to:
- A. interference of two waves of the same frequency
 - B. combination of two waves of slightly different frequency
 - C. reversal of phase of reflected wave relative to incident wave
 - D. two media having slightly different sound velocities
 - E. effect of relative motion of source and observer

ans: B

9. To produce beats it is necessary to use two waves:
- A. traveling in opposite directions
 - B. of slightly different frequencies
 - C. of equal wavelengths
 - D. of equal amplitudes
 - E. whose ratio of frequencies is an integer

ans: B

10. In order for two sound waves to produce audible beats, it is essential that the two waves have:
- A. the same amplitude
 - B. the same frequency
 - C. the same number of harmonics
 - D. slightly different amplitudes
 - E. slightly different frequencies

ans: E

11. The largest number of beats per second will be heard from which pair of tuning forks?
- A. 200 and 201 Hz
 - B. 256 and 260 Hz
 - C. 534 and 540 Hz
 - D. 763 and 774 Hz
 - E. 8420 and 8422 Hz
- ans: D
12. Two stationary tuning forks (350 and 352 Hz) are struck simultaneously. The resulting sound is observed to:
- A. beat with a frequency of 2 beats/s
 - B. beat with a frequency of 351 beats/s
 - C. be loud but not beat
 - D. be Doppler shifted by 2 Hz
 - E. have a frequency of 702 Hz
- ans: A
13. When listening to tuning forks of frequency 256 Hz and 260 Hz, one hears the following number of beats per second:
- A. zero
 - B. 2
 - C. 4
 - D. 8
 - E. 258
- ans: C
14. Two identical tuning forks vibrate at 256 Hz. One of them is then loaded with a drop of wax, after which 6 beats/s are heard. The period of the loaded tuning fork is:
- A. 0.006 s
 - B. 0.005 s
 - C. 0.004 s
 - D. 0.003 s
 - E. none of these
- ans: C
15. Which of the following properties of a sound wave determine its “pitch”?
- A. Amplitude
 - B. Distance from source to detector
 - C. Frequency
 - D. Phase
 - E. Speed
- ans: C

16. Two notes are an “octave” apart. The ratio of their frequencies is:
- A. 8
 - B. 10
 - C. $\sqrt{8}$
 - D. 2
 - E. $\sqrt{2}$
- ans: D
17. Consider two imaginary spherical surfaces with different radii, each centered on a point sound source emitting spherical waves. The power transmitted across the larger sphere is _____ the power transmitted across the smaller and the intensity at a point on the larger sphere is _____ the intensity at a point on the smaller.
- A. greater than, the same as
 - B. greater than, greater than
 - C. greater than, less than
 - D. the same as, less than
 - E. the same as, the same as
- ans: D
18. The sound intensity 5.0 m from a point source is 0.50 W/m^2 . The power output of the source is:
- A. 39 W
 - B. 160 W
 - C. 266 W
 - D. 320 W
 - E. 390 W
- ans: B
19. The standard reference sound level is about:
- A. the threshold of human hearing at 1000 Hz
 - B. the threshold of pain for human hearing at 1000 Hz
 - C. the level of sound produced when the 1 kg standard mass is dropped 1 m onto a concrete floor
 - D. the level of normal conversation
 - E. the level of sound emitted by a standard 60 Hz tuning fork
- ans: A
20. The intensity of sound wave A is 100 times that of sound wave B. Relative to wave B the sound level of wave A is:
- A. -2 db
 - B. $+2 \text{ db}$
 - C. $+10 \text{ db}$
 - D. $+20 \text{ db}$
 - E. $+100 \text{ db}$
- ans: D

21. The intensity of a certain sound wave is $6 \mu\text{W}/\text{cm}^2$. If its intensity is raised by 10 db, the new intensity (in $\mu\text{W}/\text{cm}^2$) is:
- A. 60
 - B. 6.6
 - C. 6.06
 - D. 600
 - E. 12
- ans: A
22. If the sound level is increased by 10 db the intensity increases by a factor of:
- A. 2
 - B. 5
 - C. 10
 - D. 20
 - E. 100
- ans: C
23. The sound level at a point P is 14 db below the sound level at a point 1.0 m from a point source. The distance from the source to point P is:
- A. 4.0 cm
 - B. 20 2m
 - C. 2.0 m
 - D. 5.0 m
 - E. 25 m
- ans: D
24. To raise the pitch of a certain piano string, the piano tuner:
- A. loosens the string
 - B. tightens the string
 - C. shortens the string
 - D. lengthens the string
 - E. removes some mass
- ans: B
25. A piano wire has length L and mass M . If its fundamental frequency is f , its tension is:
- A. $2Lf/m$
 - B. $4MLf$
 - C. $2Mf^2/L$
 - D. $4f^2L^3/M$
 - E. $4LMf^2$
- ans: E

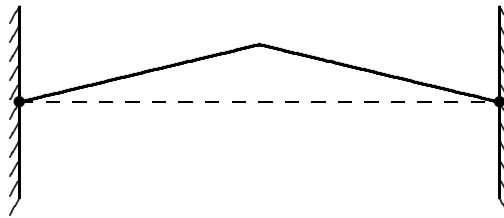
26. If the length of a piano wire (of given density) is increased by 5%, what approximate change in tension is necessary to keep its fundamental frequency unchanged?
- A. Decrease of 10%
 - B. Decrease of 5%
 - C. Increase of 5%
 - D. Increase of 10%
 - E. Increase of 20%

ans: C

27. A piano wire has a length of 81 cm and a mass of 2.0 g. If its fundamental frequency is to be 394 Hz, its tension must be:
- A. 0.32 N
 - B. 63 N
 - C. 130 N
 - D. 250 N
 - E. none of these

ans: B

28. A stretched wire of length 1.0 m is clamped at both ends. It is plucked at its center as shown. The three longest wavelengths in the wire are (in meters):



- A. 4, 2, 1
- B. 2, 1, 0.5
- C. 2, 0.67, 0.4
- D. 1, 0.5, 0.33
- E. 1, 0.67, 0.5

ans: C

29. Two identical strings, A and B, have nearly the same tension. When they both vibrate in their fundamental resonant modes, there is a beat frequency of 3 Hz. When string B is tightened slightly, to increase the tension, the beat frequency becomes 6 Hz. This means:
- A. that before tightening A had a higher frequency than B, but after tightening, B has a higher frequency than A
 - B. that before tightening B had a higher frequency than A, but after tightening, A has a higher frequency than B
 - C. that before and after tightening A has a higher frequency than B
 - D. that before and after tightening B has a higher frequency than A
 - E. none of the above

ans: D

30. Two pipes are each open at one end and closed at the other. Pipe A has length L and pipe B has length $2L$. Which harmonic of pipe B matches in frequency the fundamental of pipe A?
- A. The fundamental
 - B. The second
 - C. The third
 - D. The fourth
 - E. There are none

ans: E

31. A column of argon is open at one end and closed at the other. The shortest length of such a column that will resonate with a 200 Hz tuning fork is 42.5 cm. The speed of sound in argon must be:
- A. 85.0 m/s
 - B. 170 m/s
 - C. 340 m/s
 - D. 470 m/s
 - E. 940 m/s

ans: C

32. A tuning fork produces sound waves of wavelength λ in air. This sound is used to cause resonance in an air column, closed at one end and open at the other. The length of this column CANNOT be:
- A. $\lambda/4$
 - B. $2\lambda/4$
 - C. $3\lambda/4$
 - D. $5\lambda/4$
 - E. $7\lambda/4$

ans: B

33. A 1024 Hz tuning fork is used to obtain a series of resonance levels in a gas column of variable length, with one end closed and the other open. The length of the column changes by 20 cm from resonance to resonance. From this data, the speed of sound in this gas is:
- A. 20 cm/s
 - B. 51 cm/s
 - C. 102 cm/s
 - D. 205 m/s
 - E. 410 m/s

ans: E

34. A vibrating tuning fork is held over a water column with one end closed and the other open. As the water level is allowed to fall, a loud sound is heard for water levels separated by 17 cm. If the speed of sound in air is 340 m/s, the frequency of the tuning fork is:
- A. 500 Hz
 - B. 1000 Hz
 - C. 2000 Hz
 - D. 5780 Hz
 - E. 578,000 Hz

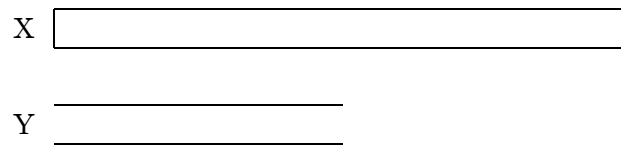
ans: B

35. An organ pipe with one end open and the other closed is operating at one of its resonant frequencies. The open and closed ends are respectively:
- A. pressure node, pressure node
 - B. pressure node, displacement node
 - C. displacement antinode, pressure node
 - D. displacement node, displacement node
 - E. pressure antinode, pressure node
- ans: B
36. An organ pipe with one end closed and the other open has length L . Its fundamental frequency is proportional to:
- A. L
 - B. $1/L$
 - C. $1/L^2$
 - D. L^2
 - E. $\sqrt{L}$
- ans: B
37. Five organ pipes are described below. Which one has the highest frequency fundamental?
- A. A 2.3-m pipe with one end open and the other closed
 - B. A 3.3-m pipe with one end open and the other closed
 - C. A 1.6-m pipe with both ends open
 - D. A 3.0-m pipe with both ends open
 - E. A pipe in which the displacement nodes are 5 m apart
- ans: C
38. If the speed of sound is 340 m/s, the length of the shortest closed pipe that resonates at 218 Hz is:
- A. 23 cm
 - B. 17 cm
 - C. 39 cm
 - D. 78 cm
 - E. 1.56 cm
- ans: C
39. The lowest tone produced by a certain organ comes from a 3.0-m pipe with both ends open. If the speed of sound is 340 m/s, the frequency of this tone is approximately:
- A. 7 Hz
 - B. 14 Hz
 - C. 28 Hz
 - D. 57 Hz
 - E. 70 Hz
- ans: D

40. The speed of sound in air is 340 m/s. The length of the shortest pipe, closed at one end, that will respond to a 512 Hz tuning fork is approximately:
- A. 4.2 cm
 - B. 9.4 cm
 - C. 17 cm
 - D. 33 cm
 - E. 66 cm
- ans: C

41. If the speed of sound is 340 m/s, the two lowest frequencies of an 0.5-m organ pipe, closed at one end, are approximately:
- A. 170 and 340 Hz
 - B. 170 and 510 Hz
 - C. 340 and 680 Hz
 - D. 340 and 1020 Hz
 - E. 57 and 170 Hz
- ans: B

42. Organ pipe Y (open at both ends) is half as long as organ pipe X (open at one end) as shown. The ratio of their fundamental frequencies $f_X:f_Y$ is:



- A. 1:1
- B. 1:2
- C. 2:1
- D. 1:4
- E. 4:1

ans: A

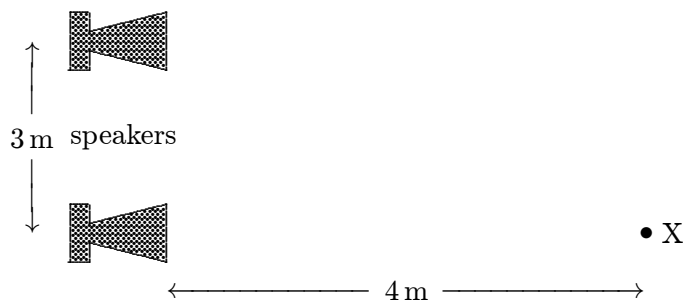
43. A 200-cm organ pipe with one end open is in resonance with a sound wave of wavelength 270 cm. The pipe is operating in its:
- A. fundamental frequency
 - B. second harmonic
 - C. third harmonic
 - D. fourth harmonic
 - E. fifth harmonic
- ans: B

44. An organ pipe with both ends open is 0.85 m long. Assuming that the speed of sound is 340 m/s, the frequency of the third harmonic of this pipe is:
- A. 200 Hz
 - B. 300 Hz
 - C. 400 Hz
 - D. 600 Hz
 - E. none of these
- ans: D

45. The “A” on a trumpet and a clarinet have the same pitch, but the two are clearly distinguishable. Which property is most important in enabling one to distinguish between these two instruments?
- A. Intensity
 - B. Fundamental frequency
 - C. Displacement amplitude
 - D. Pressure amplitude
 - E. Harmonic content
- ans: E

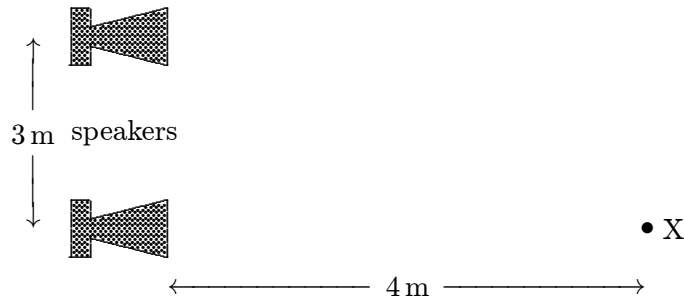
46. The valves of a trumpet and the slide of a trombone are for the purpose of:
- A. playing short (staccato) notes
 - B. tuning the instruments
 - C. changing the harmonic content
 - D. changing the length of the air column
 - E. producing gradations in loudness
- ans: D

47. Two small identical speakers are connected (in phase) to the same source. The speakers are 3 m apart and at ear level. An observer stands at X, 4 m in front of one speaker as shown. If the amplitudes are not changed, the sound he hears will be most intense if the wavelength is:



- A. 1 m
 - B. 2 m
 - C. 3 m
 - D. 4 m
 - E. 5 m
- ans: A

48. Two small identical speakers are connected (in phase) to the same source. The speakers are 3 m apart and at ear level. An observer stands at X, 4 m in front of one speaker as shown. The sound she hears will be most intense if the wavelength is:



- A. 5 m
- B. 4 m
- C. 3 m
- D. 2 m
- E. 1 m

ans: E

49. The rise in pitch of an approaching siren is an apparent increase in its:

- A. speed
- B. amplitude
- C. frequency
- D. wavelength
- E. number of harmonics

ans: C

50. The diagram shows four situations in which a source of sound S with variable frequency and a detector D are either moving or stationary. The arrows indicate the directions of motion. The speeds are all the same. Detector 3 is stationary. The frequency detected is the same. Rank the situations according to the frequency of the source, lowest to highest.



- A. 1, 2, 3, 4
- B. 4, 3, 2, 1
- C. 1, 3, 4, 2
- D. 2, 1, 2, 3
- E. None of the above

ans: B

51. A stationary source generates 5.0 Hz water waves whose speed is 2.0 m/s. A boat is approaching the source at 10 m/s. The frequency of these waves, as observed by a person in the boat, is:
- A. 5.0 Hz
 - B. 15 Hz
 - C. 20 Hz
 - D. 25 Hz
 - E. 30 Hz

ans: E

52. A stationary source S generates circular outgoing waves on a lake. The wave speed is 5.0 m/s and the crest-to-crest distance is 2.0 m. A person in a motor boat heads directly toward S at 3.0 m/s. To this person, the frequency of these waves is:
- A. 1.0 Hz
 - B. 1.5 Hz
 - C. 2.0 Hz
 - D. 4.0 Hz
 - E. 8.0 Hz

ans: D

53. A stationary source emits a sound wave of frequency f . If it were possible for a man to travel toward the source at the speed of sound, he would observe the emitted sound to have a frequency of:
- A. zero
 - B. $f/2$
 - C. $2f/3$
 - D. $2f$
 - E. infinity

ans: D

54. A source emits sound with a frequency of 1000 Hz. It and an observer are moving in the same direction with the same speed, 100 m/s. If the speed of sound is 340 m/s, the observer hears sound with a frequency of:
- A. 294 Hz
 - B. 545 Hz
 - C. 1000 Hz
 - D. 1830 Hz
 - E. 3400 Hz

ans: C

55. A source emits sound with a frequency of 1000 Hz. It and an observer are moving toward each other, each with a speed of 100 m/s. If the speed of sound is 340 m/s, the observer hears sound with a frequency of:
- A. 294 Hz
 - B. 545 Hz
 - C. 1000 Hz
 - D. 1830 Hz
 - E. 3400 Hz

ans: D

56. A source emits sound with a frequency of 1000 Hz. It is moving at 20 m/s toward a stationary reflecting wall. If the speed of sound is 340 m/s an observer at rest directly behind the source hears a beat frequency of:
- A. 11 Hz
 - B. 86 Hz
 - C. 97 Hz
 - D. 118 Hz
 - E. 183 Hz

ans: D

57. In each of the following two situations a source emits sound with a frequency of 1000 Hz. In situation I the source is moving at 100 m/s toward an observer at rest. In situation II the observer is moving at 100 m/s toward the source, which is stationary. The speed of sound is 340 m/s. The frequencies heard by the observers in the two situations are:

- A. I: 1417 Hz; II: 1294 Hz
- B. I: 1417 Hz; II: 1417 Hz
- C. I: 1294 Hz; II: 1294 Hz
- D. I: 773 Hz; II: 706 Hz
- E. I: 773 Hz; II: 773 Hz

ans: A

58. The Doppler shift formula for the frequency detected is

$$f = f' \frac{v \pm v_D}{v \mp v_S},$$

where f' is the frequency emitted, v is the speed of sound, v_D is the speed of the detector, and v_S is the speed of the source. Suppose the source is traveling at 5 m/s away from the detector, the detector is traveling at 7 m/s toward the source, and there is a 3-m/s wind blowing from the source toward the detector. The values that should be substituted into the Doppler shift equation are:

- A. $v_D = 7$ m/s and $v_S = 5$ m/s
- B. $v_D = 10$ m/s and $v_S = 8$ m/s
- C. $v_D = 4$ m/s and $v_S = 2$ m/s
- D. $v_D = 10$ m/s and $v_S = 2$ m/s
- E. $v_D = 4$ m/s and $v_S = 8$ m/s

ans: B

59. A plane produces a sonic boom only when:
- A. it emits sound waves of very long wavelength
 - B. it emits sound waves of high frequency
 - C. it flies at high altitudes
 - D. it flies on a curved path
 - E. it flies faster than the speed of sound

ans: E

60. If the speed of sound is 340 m/s a plane flying at 400 m/s creates a conical shock wave with an apex half angle of:
- A. 0 (no shock wave)
 - B. 32°
 - C. 40°
 - D. 50°
 - E. 58°
- ans: E

61. The speed of sound is 340 m/s . A plane flies horizontally at an altitude of $10,000 \text{ m}$ and a speed of 400 m/s . When an observer on the ground hears the sonic boom the horizontal distance from the point on its path directly above the observer to the plane is:
- A. 5800 m
 - B. 6200 m
 - C. 8400 m
 - D. $12,000 \text{ m}$
 - E. $16,000 \text{ m}$
- ans: B