

## Sound Waves

- What is the speed of sound in air at
  - $10^{\circ}\text{C}$
  - $-30^{\circ}\text{C}$ ?
- A fan at a baseball game is 100 m from home plate. If the speed of sound is 350 m/s, how long after the batter actually hits the ball does the fan hear the crack of the bat?
- A lightning flash is seen 10.0 s before the rumble of the thunder is heard. Find the distance to the lightning flash if the temperature is  $20^{\circ}\text{C}$ .
- 3.5 s after a woman makes a sound, the echo returns from a nearby wall. How far is the woman from the wall, assuming the speed of sound is 350 m/s?
- An armed forces ship patrolling the ocean receives its own signals back, by underwater reflection, 4.5 s after emitting them. How far away is the reflecting surface if the speed of sound in water is 1450 m/s?
- A person is listening to music at a loudness of 50 dB. If the volume is increased so that it is twice as loud, what is the new loudness?
- You sound two tuning forks together. One has a frequency of 300 Hz and the other a frequency of 302 Hz. What do you hear?
- A tuning fork with a frequency of 440 Hz is struck with a second fork, and you count 20 beats in 5 s. What are the possible frequencies of the second tuning fork?
- The fundamental frequency produced by a guitar string is 400 Hz, what is the frequency of the second overtone?
- A closed tube 30.0 cm long resonates at its shortest resonant length with a tuning fork in a room where the air temperature is  $25^{\circ}\text{C}$ . Calculate
  - the frequency of the sound waves.
  - the wavelength of the sound waves.
- An open organ pipe has a fundamental frequency of 262 Hz at room temperature. What is the length of the pipe?

Answers:

- |                          |                        |
|--------------------------|------------------------|
| 1. a) 337 m/s b) 313 m/s | 7. 2 Hz                |
| 2. 0.286 s               | 8. 444 Hz or 436 Hz    |
| 3. 3430 m                | 9. 800 Hz              |
| 4. 610 m                 | 10. a) 288 Hz b) 1.2 m |
| 5. 3263 m                | 11. 0.655 m            |
| 6. 60 dB                 |                        |

$$1. (a) v = 331 + 0.6(10) = \underline{337 \text{ m/s}}$$

$$(b) v = 331 + 0.6(-30) = \underline{313 \text{ m/s}}$$

$$2. d = 100 \text{ m}$$

$$v = 350 \text{ m/s}$$

$$t = ?$$

$$v = \frac{d}{t}$$

$$350 = \frac{100}{t}$$

$$t = \underline{0.286 \text{ s}}$$

$$3. d = ?$$

$$t = 10 \text{ s}$$

$$v = 331 + .6(20) = 343 \text{ m/s}$$

$$v = \frac{d}{t}$$

$$343 = \frac{d}{10 \text{ s}}$$

$$d = \underline{3430 \text{ m}}$$

$$4. d = ?$$

$$t = 3.5 \text{ s} / 2 = 1.75 \text{ s}$$

$$v = 350 \text{ m/s}$$

$$v = \frac{d}{t}$$

$$350 = \frac{d}{1.75}$$

$$d = \underline{613 \text{ m}}$$

$$5. d = ?$$

$$t = 4.5 \text{ s} / 2 = 2.25 \text{ s}$$

$$v = 1450 \text{ m/s}$$

$$v = \frac{d}{t}$$

$$1450 = \frac{d}{2.25}$$

$$d = \underline{3263 \text{ m}}$$

$$6. 60 \text{ dB}$$

$$7. \text{ beat frequency} = |f_1 - f_2|$$

$$= |300 - 302| = \underline{2 \text{ Hz}}$$

$$8. \text{ beat frequency} = \frac{20}{5} = 4 \text{ Hz}$$

$$\text{so... } 440 + 4 = \underline{444 \text{ Hz}}$$

$$\text{or } 440 - 4 = \underline{436 \text{ Hz}}$$

$$9. f_2 = 2f_1 \quad 800 \text{ Hz}$$

$$10. (a) v = 331 + .6(25) = 346 \text{ m/s}$$

$$f_1 = \frac{v}{4L} = \frac{346}{4(.3)} = \underline{288 \text{ Hz}}$$

$$(b) v = f\lambda$$

$$346 = 288\lambda$$

$$\lambda = \underline{1.2 \text{ m}}$$

$$11. v = 331 + .6(20) = 343 \text{ m/s}$$

$$f_1 = \frac{v}{2L}$$

$$262 = \frac{343}{2L}$$

$$L = \underline{0.65 \text{ m}}$$