1. What is the frequency, in Hertz, that corresponds to each of the following periods: (a) 0.1 s, (b) 5 s, (c) 1/60 s?
2. What is the period, in seconds, that corresponds to each of the following frequencies: (a) 10 Hz, (b) 0.2 Hz, (c) 60 Hz?
3. A skipper on a boat notices wave crests passing his anchor chain every 5 s. He estimates the distance between wave crests to be 15 m. He also correctly estimates the speed of the waves. What is this speed?
4. A weight suspended from a spring is seen to bob up and down over a distance of 20 cm twice each second. What is its frequency? Its period? Its amplitude?
5. Radio waves travel at the speed of light – 300,000 km/s. What is the wavelength of radio waves received at 100.1 MHz on your FM radio dial?
6. A mosquito flaps its wings 600 vibrations per second, which produces the annoying 600 Hz buzz. How far does the sound travel between wing beats? In other words, calculate the wavelength of the mosquito’s sound. Sound travels at 340 m/s in air.
7. On a keyboard, you strike middle C, whose frequency is 256 Hz. (a) What is the period of one vibration of this tone? (b) As the sound leaves the instrument at a speed of 340 m/s, what is its wavelength in air?
8. The wavelength of the signal from TV Channel 6 is 3.42 m. Does Channel 6 broadcast on a frequency above or below the FM radio band, which is 88 to 108 MHz?
9. What is a wiggle in time called? A wiggle in space and time?
10. Distinguish between the propagation of sound waves and light waves.
11. What is the source of all waves?
12. What feature about a pendulum makes it useful in a grandfather clock?
13. What is meant by the period of a pendulum?
14. Distinguish between these different parts of a wave: period, amplitude, wavelength, and frequency.
15. How many vibrations per second are represented in a radio wave of 101.7 MHz?
16. How do frequency and period relate to each other?
17. In one word, what is it that moves from source to receiver in wave motion?
18. Does the medium in which a wave travels move with the wave? Give examples to support your answer.
19. What is the relationship among frequency, wavelength, and wave speed?
20. In what direction are the vibrations relative to the direction of wave travel in a transverse wave?
21. In what direction are the vibrations relative to the direction of wave travel in a longitudinal wave?
22. The wavelength of a transverse wave is the distance between successive crests (or troughs). What is the wavelength of a longitudinal wave?
23. What is meant by the superposition principle?
24. Distinguish between constructive interference and destructive interference.
25. What kinds of waves can show interference?
26. What causes a standing wave?
27. What is a node? What is an antinode?
28. In the Doppler effect, does frequency change? Does wavelength change? Does wave speed change?
29. Can the Doppler effect be observed with longitudinal waves, transverse waves, or both?
Answers:

1. (a) \( f = \frac{1}{T} = \frac{1}{0.10 \text{ s}} = 10 \text{ Hz} \); (b) \( f = \frac{1}{5} = 0.2 \text{ Hz} \); (c) \( f = \frac{1}{(1/60)} \text{ s} = 60 \text{ Hz} \).

2. Using \( T = 1/f \), (a) \( 0.10 \text{ s} \), (b) \( 5 \text{ s} \), (c) \( 1/60 \text{ s} \).

3. The skipper notes that 15 meters of wave pass each 5 seconds, or equivalently, that 3 meters pass each 1 second, so the speed of the wave must be

\[
\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{15 \text{ m}}{5 \text{ s}} = 3 \text{ m/s}.
\]

Or in wave terminology: \( \text{Speed} = \text{frequency} \times \text{wavelength} = \frac{1}{5 \text{ Hz}}(15 \text{ m}) = 3 \text{ m/s} \).

4. a. \( \text{Frequency} = 2 \text{ bobs/second} = 2 \text{ hertz} \); b. \( \text{Period} = \frac{1}{f} = \frac{1}{2} \text{ second} \); and the amplitude is the distance from the equilibrium position to maximum displacement, one-half the 20-cm peak-to-peak distance, or \( 10 \text{ cm} \).

5. To say that the frequency of radio waves is 100 MHz and that they travel at 300,000 km/s, is to say that there are 100 million wavelengths packed into 300,000 kilometers of space. Or expressed in meters, 300 million m of space. Now 300 million m divided by 100 million waves gives a wavelength of 3 meters per wave. Or

\[
\text{Wavelength} = \frac{\text{speed}}{\text{frequency}} = \frac{(300 \text{ megameters/s})}{100 \text{ megahertz}} = 3 \text{ m}.
\]

6. \( d = vt = (340 \text{ m/s})(1/600 \text{ s}) = 0.57 \text{ m} \). Or use speed = wavelength x frequency to get wavelength = speed/frequency = \( (340 \text{ m/s})/(600 \text{ Hz}) = 0.57 \text{ m} \).

7. (a) \( \text{Period} = \frac{1}{\text{frequency}} = \frac{1}{(256 \text{ Hz})} = 0.00391 \text{ s} \), or 3.91 ms. (b) \( \text{Speed} = \text{wavelength} \times \text{frequency} \), so \( \text{wavelength} = \frac{\text{speed}}{\text{frequency}} = \frac{(340 \text{ m/s})}{(256 \text{ Hz})} = 1.33 \text{ m} \).

8. Below. \( \text{Speed} = \text{frequency} \times \text{wavelength} \), so \( \text{frequency} = \frac{\text{speed}}{\text{wavelength}} = \frac{(3 \times 10^8 \text{ m/s})}{(3.42 \text{ m})} = 8.77 \times 10^7 \text{ Hz} = 87.7 \text{ MHz} \), just below the FM band.

9. Vibration; wave.

10. Sound waves propagate through a material medium; light waves, which are vibrations of pure energy, need no material for propagation.

11. Something that is vibrating.

12. Regularity of vibration.

13. The time of a to-and-fro swing.

14. Period is the time for one complete vibration. Amplitude is the distance from the midpoint to the crest (or trough) of a wave. Wavelength is the distance along the wave between any successive identical parts of the wave. Frequency specifies the number of to-and-fro vibrations in a given time, usually one second.

15. 101.7 million vibrations per second.

16. They are the inverse of each other.

17. Energy (also, a disturbance).

18. No. A disturbance in a medium moves, not the medium itself. Water in a pond or grass in a field propagate waves, but go nowhere.

19. Wave speed = frequency x wavelength.

20. Perpendicular (or transverse) to the direction of wave travel.

21. Along the direction of wave travel.

22. Distance between successive compressions (or rarefactions).

23. When more than one wave occupies the same space at the same time, the displacements add at every point.

24. Constructive interference occurs when waves overlap in phase, and add. Destructive interference occurs when out-of-phase waves overlap, and cancel.

25. All waves.

26. Interference of a wave with its reflection.

27. A node is the stationary part of a standing wave, a region of minimal or zero displacement and minimal or zero energy. An antinode is a region of maximum displacement and maximum energy.


29. Both.