

Academic Physics - General Wave Questions

1. The speed of sound in sea water is about 1530 m/s. If a sound wave has a frequency of 250 Hz, what is its wavelength in sea water?
2. Cicadas produce a sound that has a frequency of 123 Hz. What is the wavelength of this sound in the air? The speed of sound in air is 341 m/s.
3. Human fingers are very sensitive, detecting vibrations with amplitudes as low as 2.0×10^{-5} m. Consider a sound wave with a wavelength exactly 1000 times greater than the lowest amplitude detectable by fingers. What is this wave's frequency?
4. A nineteenth-century fisherman's cottage in England is only 2.54 m long. Suppose a fisherman whistles inside the cottage, producing a note that has a wavelength that exactly matches the length of the house. What is the whistle's frequency? The speed of sound in air is 334 m/s.
5. The lowest vocal note in the classical repertoire is low D ($f = 73.4$ Hz), which occurs in an aria in Mozart's opera *Die Entführung aus dem Serail*. If low D has a wavelength of 4.50 m, what is the speed of sound in air?
6. Dolphins can hear ultrasound with frequencies up to 280 kHz. What is the speed of sound in water if the wavelength of ultrasound with a frequency of 2.80×10^5 Hz is 0.510 cm? How long would it take this sound wave to travel to a dolphin 3.00 km away?
7. A dolphin can hear sounds with frequencies up to 280 kHz. What is the speed of sound in water if a wave with this frequency has a wavelength of 0.51 cm?
8. Waves in a lake are 6.0 m apart and pass a person on a raft every 2.0 s. What is the speed of the waves?
9. Sonar is a device that uses reflected sound waves to measure underwater depths. If a sonar signal has a frequency of 288 Hz, and the wavelength is 5.00 m, what is the speed of the sonar signal in water?
10. A buoy on the ocean bobs up and down. The waves have a wavelength of 2.5 m, and a frequency of 1.6 Hz. What is the speed of the waves?
11. A dog whistle is designed to produce a sound with a frequency beyond that which can be heard by humans (between 20 000 Hz and 27 000 Hz). If a particular whistle produces a sound with a frequency of 2.5×10^4 Hz, what is the sound's wavelength? Assume the speed of sound in air to be 341 m/s.
12. The lowest pitch that the average human can hear has a frequency of 20.0 Hz. If sound with this frequency travels through air with a speed of 341 m/s, what is its wavelength?

Academic Physics - 12.B Pendulum

1. A simple pendulum with a length of 0.3 m would have a period of 1.16 s on Venus. Calculate the acceleration of gravity on Venus.
2. On Mars, a simple pendulum with a length of 65.0 cm would have a period of 2.62 s. Calculate the acceleration of gravity on Mars.
3. On Mercury, a simple pendulum with a length of 1.14 m would have a period of 3.55 s. What is the acceleration of gravity on Mercury?
4. A simple pendulum with a length of 50.0 cm would have a period of 2.99 s on Pluto. Calculate the acceleration of gravity on Pluto.
5. Find the length of a pendulum that oscillates with a frequency of 1.0 Hz.
6. Find the length of a pendulum that oscillates with a frequency of 0.50 Hz.
7. Find the length of a pendulum that oscillates with a frequency of 2.5 Hz.
8. Calculate the period and frequency of a 6.200 m long pendulum in Oslo, Norway, where $g = 9.819 \text{ m/s}^2$.
9. Calculate the period and frequency of a 2.500 m long pendulum in Quito, Ecuador, where $g = 9.780 \text{ m/s}^2$.
10. Calculate the period and frequency of a 3.120 m long pendulum in Cairo, Egypt, where $g = 9.793 \text{ m/s}^2$.

Academic Physics - 12.C Mass-Spring

1. Honeybee scouts inform other honeybees where to find food by flapping their wings and “waggle-dancing.” During part of the dance, a scout bee’s wings flap with a maximum frequency of 300 Hz. Suppose a mass is attached to a spring with a spring constant of 8.65×10^4 N/m. How large is the mass if its oscillation frequency is the same as the wings of a waggle-dancing bee?
2. On Halloween, you see an “alien” that has one antenna made of a glittery foam ball connected to a spring. The springs oscillate with a period of 0.079 s, and have a spring constant of 63 N/m. Find the mass of the ball.
3. A farmer rides over a bumpy field on his tractor. The tractor seat is supported by a spring with a spring constant of 2031 N/m. As the farmer drives over a bump, the seat oscillates at a frequency of 0.79 Hz. For the first few seconds, the vibration approximates simple harmonic motion. Find the farmer’s mass if the tractor seat acts like a spring scale.
4. A 32 N sack of potatoes vibrates with a period of 0.42 s placed on a spring scale. What is the spring constant?
5. A 66 N pumpkin vibrates with a period of 2.9 s when attached to the end of a spring scale. What is the spring constant?
6. As the wind moves the bough of a tree, it oscillates up and down. During the first few seconds, it approximates simple harmonic motion. If the bough has a weight of 87 N and oscillates with a period of 0.64 s, what is the spring constant of the bough?
7. A certain trampoline acts like a single spring with a spring constant of 364 N/m. If a 24kg child jumps on the trampoline, what would be the period of oscillation?
8. Two children jump on their parent’s bed (when the parents are not looking). The combined mass of both kids is 55 kg. The mattress is supported by 36 springs, each with a spring constant of 458 N/m. If the children jump at the same time, what would be the period of oscillation?
9. An 8.2 kg infant is placed in a jumper that is made of a seat that is suspended from a door frame by a spring. If the spring has a spring constant of 221 N/m. Calculate the period of oscillation.
10. Your friend’s key chain is coiled like a spring. Three keys, each with a mass of 24 g, are on the chain. When your friend removes the keys from a pocket, the keys bob up and down. If the key chain has a spring constant of 99 N/m, what is the frequency of oscillation?

CHAPTER

14

Chapter Assessment

Vibrations and Waves**Understanding Physics Concepts**

Circle the letter of the choice that best completes the statement.

- The time it takes for a wave to complete one wave cycle is the wave's _____.
 - amplitude
 - period
 - wavelength
 - frequency
- The distance from the trough of a wave to the adjacent trough is the _____.
 - amplitude
 - period
 - wavelength
 - speed
- Any motion that repeats in a regular cycle is known as _____ motion.
 - transverse
 - wave
 - simple harmonic
 - periodic
- The number of times a wave cycle repeats each second is the _____ of the wave.
 - period
 - frequency
 - velocity
 - wavelength
- The bending of waves at the boundary of two different media is known as _____.
 - refraction
 - reflection
 - incidence
 - diffraction
- _____ occurs when two or more waves move through a medium at the same time.
 - refraction
 - reflection
 - interference
 - resonance
- The rate of energy transfer for a particular wave is directly proportional to the _____.
 - amplitude
 - square of the amplitude
 - frequency
 - square of the frequency
- The speed of a wave is equal to _____ times frequency.
 - energy transfer
 - amplitude
 - period
 - wavelength

CHAPTER

14 Supplemental Problems

Vibrations and Waves

- A spring stretches by 25.0 cm when a 0.500-kg mass is suspended from its end.
 - Determine the spring constant.
 - How much elastic potential energy is stored in the spring when it is stretched this far?
- A spring has a spring constant of 135 N/m. How far must it be compressed so that 4.39 J of elastic potential energy is stored in the spring?
- On a planet where the gravitational acceleration is five times g on Earth, a pendulum swings back and forth with a period of 1.22 s. What is the length of the pendulum?
- Sonya hears water dripping from the eaves of the house onto a porch roof. She counts 30 drops in 1.0 min.
 - What is the frequency of the drops?
 - What is the period of the drops?
- Hiroshi is generating waves on a rope by flipping the rope up and down. Each motion up or down lasts 0.20 s. The distance from a crest to a trough is 0.40 m.
 - What is the amplitude of the wave?
 - What is the frequency of the waves?
- A water wave travels a distance of 15 m in 1 min. When this wave passes a point where a cork is floating in the water, it causes the cork to move up and down 12 times in 15 s.
 - What is the speed of this water wave?
 - What is the wavelength of this water wave?
 - What is the period of this water wave?
- A Love wave—one of the four types of waves associated with earthquakes—is a transverse wave in which the surface of Earth moves back and forth as the wave passes. What is the speed of a Love wave that has a period of 150 s and a wavelength of 620 km?
- A pulse with an amplitude of 0.53 m travels to the right along a rope. Another pulse, with an amplitude of -0.24 m, travels to the left along the same rope. The two pulses approach each other. What is the amplitude of the rope at the point where the midpoints of the pulses pass each other?
- Part **a** of the figure below shows a pulse traveling at a speed of 1.0 m/s in a coil spring to which a second spring is attached at point A. Part **b** of the figure shows the springs a short time later.

 - What is the amplitude of the incident pulse?
 - What is the speed of the reflected pulse?
 - What is the speed of the transmitted pulse?

14 Supplemental Problems*continued*

- 10.** A physics teacher attaches an electric oscillator to one end of a 2.0-m horizontal spring and attaches the other end of the spring to a stationary hook in the wall. She adjusts the frequency of the oscillator to produce a standing wave in the spring. Students observe that the standing wave has three nodes and two antinodes. She then doubles the frequency of the oscillations and produces another standing wave. How many nodes and antinodes do the students observe in the new standing wave?
- 11.** What magnitude force will compress a spring so that the spring elastic potential increases by 0.24 J? The spring constant is 18 N/cm.
- 12.** Each back-and-forth movement of the bob in a small pendulum clock releases a cog on a wheel. As the cog is released, the wheel undergoes a slight rotation. If the release of three cogs moves the second hand of the clock forward 1.0 s, what is the length of the pendulum?
- 13.** Calculate the frequency in hertz of each of the following:
- a.** a “new” moon (period = 27.3 days)
 - b.** a day on Earth
 - c.** a breath (Assume a breathing rate of 8–12 breaths in 60.0 s.)
 - d.** a heart beat (Assume a heart rate of 1.0–1.6 beats per second.)
- 14.** The distance between four consecutive antinodes of a standing wave in a spring is 42 cm. What is the wavelength of the standing wave? *Hint: The distance between two consecutive antinodes in a standing wave represents 0.5λ .*