

Developing Sine Wave Equations

Using distance: $y = A \sin\left(\frac{2\pi}{\lambda} x\right)$ and using time: $y = A \sin\left(\frac{2\pi}{T} t\right)$ in radian mode.

And the wave formulas $v = f\lambda$ and $T = \frac{1}{f}$

Provide the sinusoidal function for each wave. Sketch and label each wave.

A rope oscillates with an amplitude of 2 cm, completing 4 full cycles in 1 second. Find the period of this motion and write the sine equation.

A test spring in a physics lab moves up to 1 cm from its rest position, finishing 15 cycles in 3 seconds. Calculate the spring's period, then model its vertical displacement with a sine function.

Shallow water waves, each crest 0.5 cm high, move across the tank surface at 0.4 m/s. The wave frequency is 2 Hz. Find the wavelength and write the wave equation in terms of position.

A taut steel wire carries waves of 0.2 mm amplitude at 200 m/s. The wire is driven at 50 Hz. Find the wavelength and express the traveling wave as a function.

An ultrasound transducer emits sound at a 3 Pa amplitude, traveling through air at 340 m/s. With a frequency of 40,000 Hz, students can determine the wavelength and create the space-time wave equation.

Infrared light from an LED has an electric field amplitude of 2 V/m and travels at 3×10^8 m/s. The light's frequency is 3×10^{14} Hz. Compute its wavelength and write the corresponding wave function.

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- a) Early in the morning, surfers notice ocean swells cresting about **1.8 meters** above the calm water. These waves roll in, spaced **9 meters** between consecutive crests, before they break on the shoreline.
- b) A child snaps a rope and observes each wave rising **12 centimeters** above the resting level. The wave pattern repeats every **35 centimeters** along the rope until it settles back to stillness.
- c) Dropping a pebble into a tranquil pond, a student watches circular ripples that crest **3 centimeters** above the calm surface. Each crest is spaced **18 centimeters** apart, spreading outward in ever-widening rings.
- d) When a guitarist plucks the **D-string**, the displacement peaks at **0.6 centimeters** above the resting position. The wave along the string measures **12 centimeters** from crest to crest, resulting in a resonant tone.
- e) Two friends generate a standing wave on a long rope, swinging it so the rope moves up to **25 centimeters** above the midpoint. They observe crests appearing **1.2 meters** apart, forming a rhythmic pattern of nodes and antinodes.
- f) In a simplified diagram, a light wave's electric field rises to about **0.8 volts per meter** above zero. Consecutive crests of this wave are **550 nanometers** apart, placing it squarely within the visible spectrum.
- g) In a **robotics workshop**, an engineer observes a control signal on the oscilloscope. The waveform peaks at **3.2 volts** above the baseline. Each successive crest arrives every **4 milliseconds**, forming steady pulses that drive the servo motor.
- h) A mild **aftershock** causes the seismograph pen at a field station to deflect about **3 millimeters** above its resting line. Each wave peak repeats roughly every **2.5 seconds**, recording the tremor's ongoing vibrations.
- i) A small **mechanical metronome** oscillates, displacing about **6 degrees** on each side of its resting point. It completes **2 cycles per second**, maintaining a sharp, regular tempo for musicians.
- j) In a **veterinary clinic**, a dog's heartbeat trace on a monitor spikes **0.15 volts** above the baseline. It repeats **1.25 times per second**, indicating the dog's calm and steady pulse.
- k) A **solar-powered inverter** delivers an alternating voltage waveform peaking at about **150 volts**. The inverter cycles **50 times each second**, matching many standard European power systems.
- l) On a **microcontroller board**, a small LED flips from 0 volts to its peak of 5 volts in a quick flash. The blinking repeats **5 times per second**, creating a rapid on-off pattern.