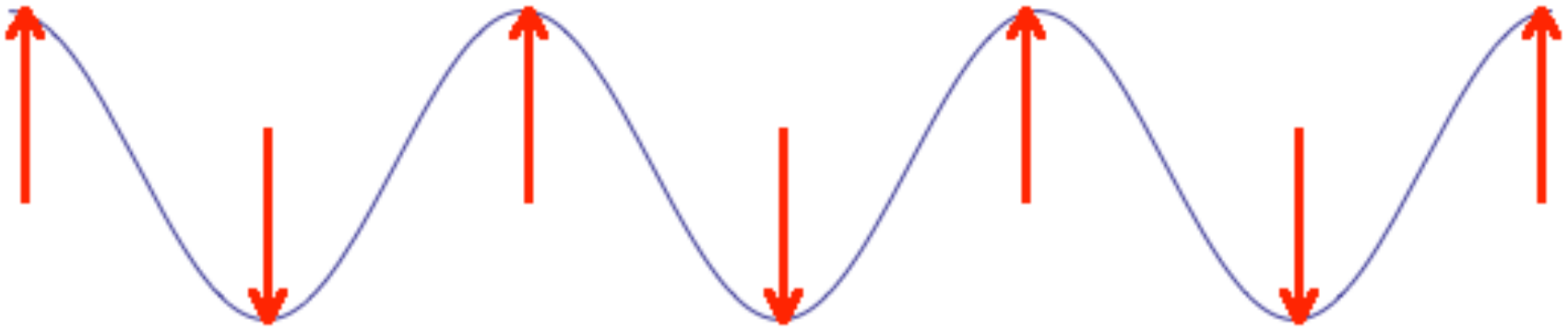
Sound Waves

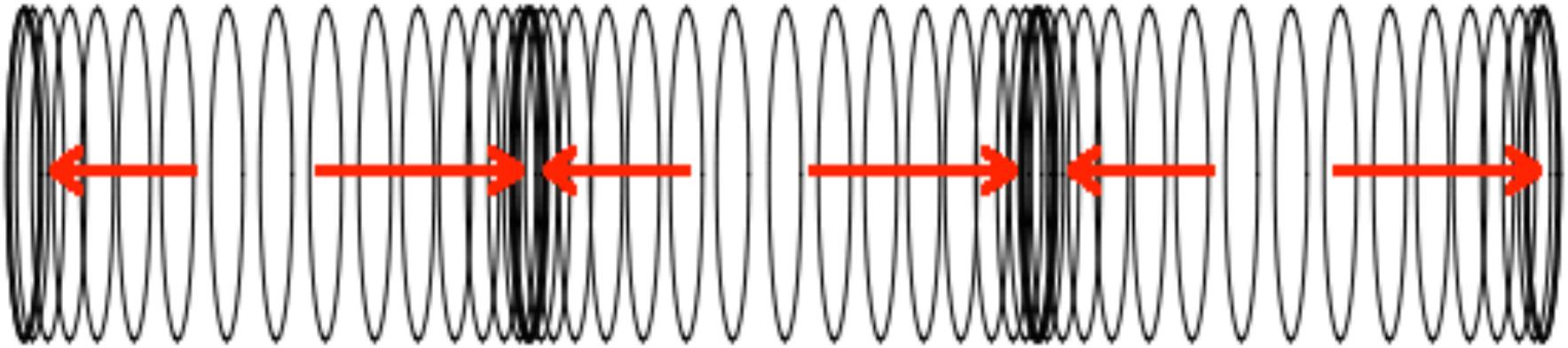
What is a mechanical wave?

The transfer of energy by an oscillation in a medium (or material).
The material does not move, but the wave does.

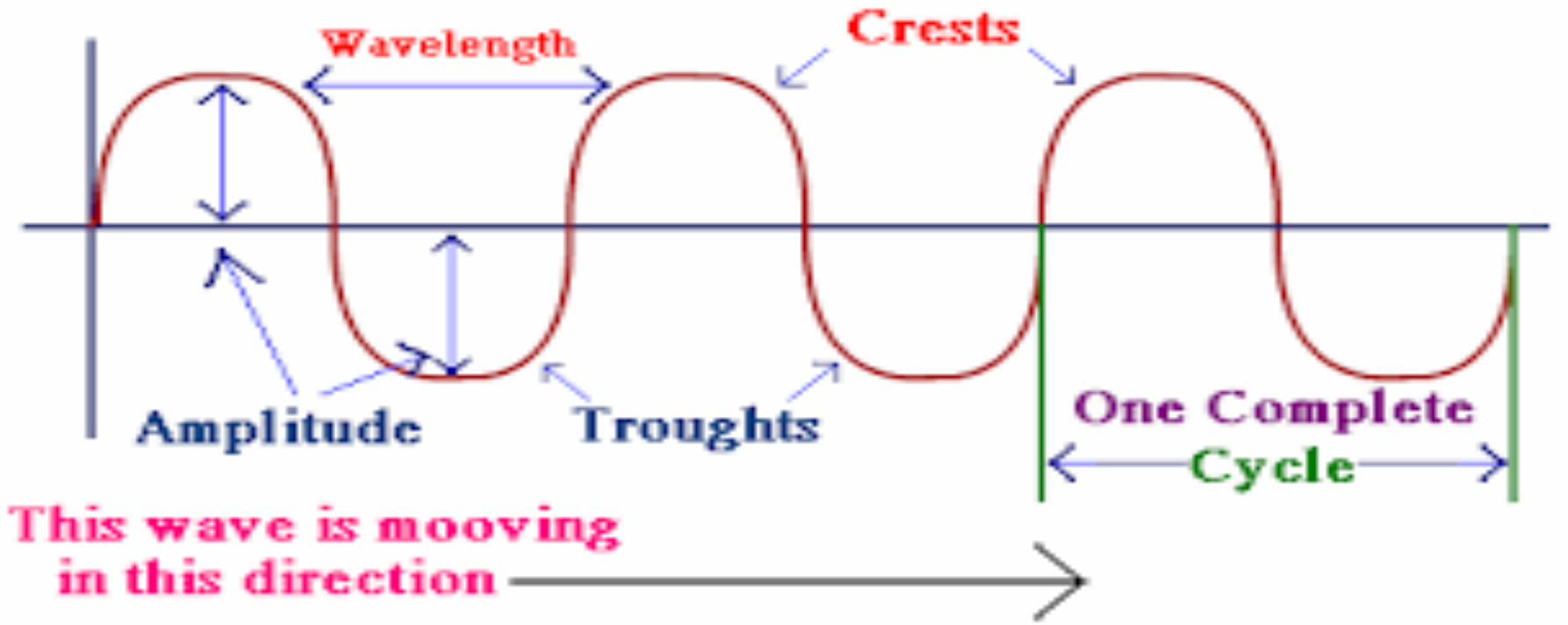
Transverse Waves



Longitudinal Waves



Characteristics of Transverse Waves



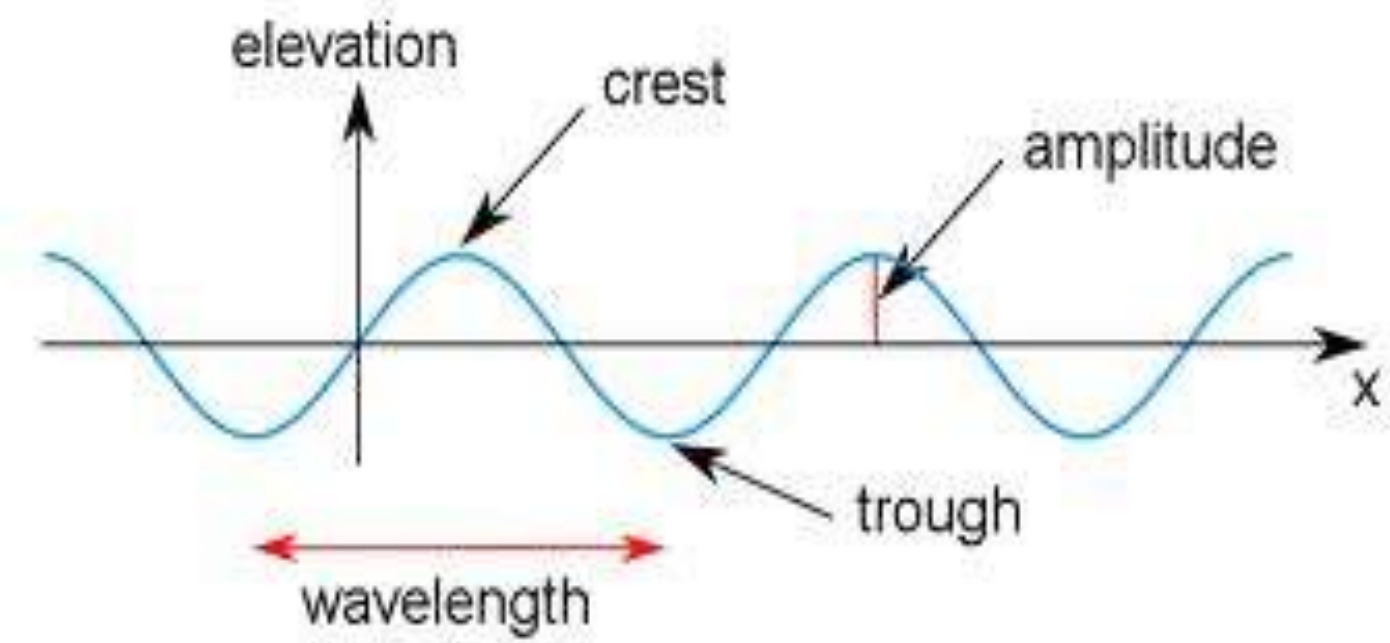
Characteristics of Longitudinal Waves

Compression: the high pressure region of the wave (“peak”)

Rarefaction: the low pressure region of the wave (“trough”)

Wavelength: the distance from one point on the wave to the next point at the same position, going in the same direction

Frequency and Period



Example: Period and Frequency

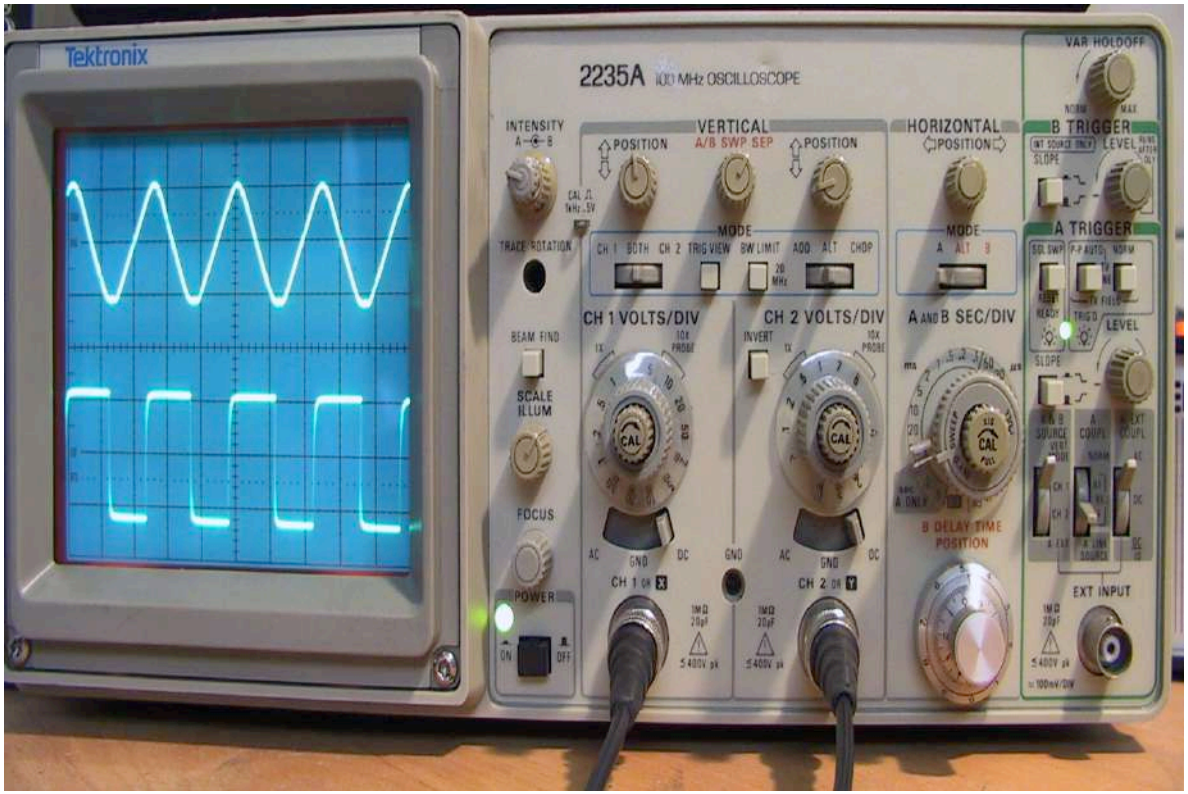
The Sears Tower sways back and forth at a frequency of about 0.1 Hz.

What is the period of vibration?

$f = 1/T = 0.1$ Hz

$T = 1/0.1$ Hz $= 10$ s

Exploring Sound Using an Oscilloscope



Universal Wave Equation

Since speed is equal to distance per unit time, the speed of a wave is:

$$v=\lambda f$$

where λ is the wavelength and *f* is th frequency. This is the **Universal Wave Equation**.

Example

Sonar is a device that uses reflected sound waves to measure underwater depths. There is a sonar signal that has a frequency of 288 Hz. If the speed of sound in water is 1.45×10^3 m/s,what is the wavelength of the sonar signal?

Answer

f = 288 Hz

v = 1.45 x 10^3 m/s

$v = \lambda f$

$v/f = \lambda$

1.45 x 10^3 m/s/288 Hz= 0.0106 m

The wavelength is 1.06 x 10^{-2} m.

Example

Cicadas produce a buzzing sound that has a wavelength in air of 2.69 m. If the speed of sound in air is 343 m/s.

What is the frequency of the sound produced by a cicada? What is its period?

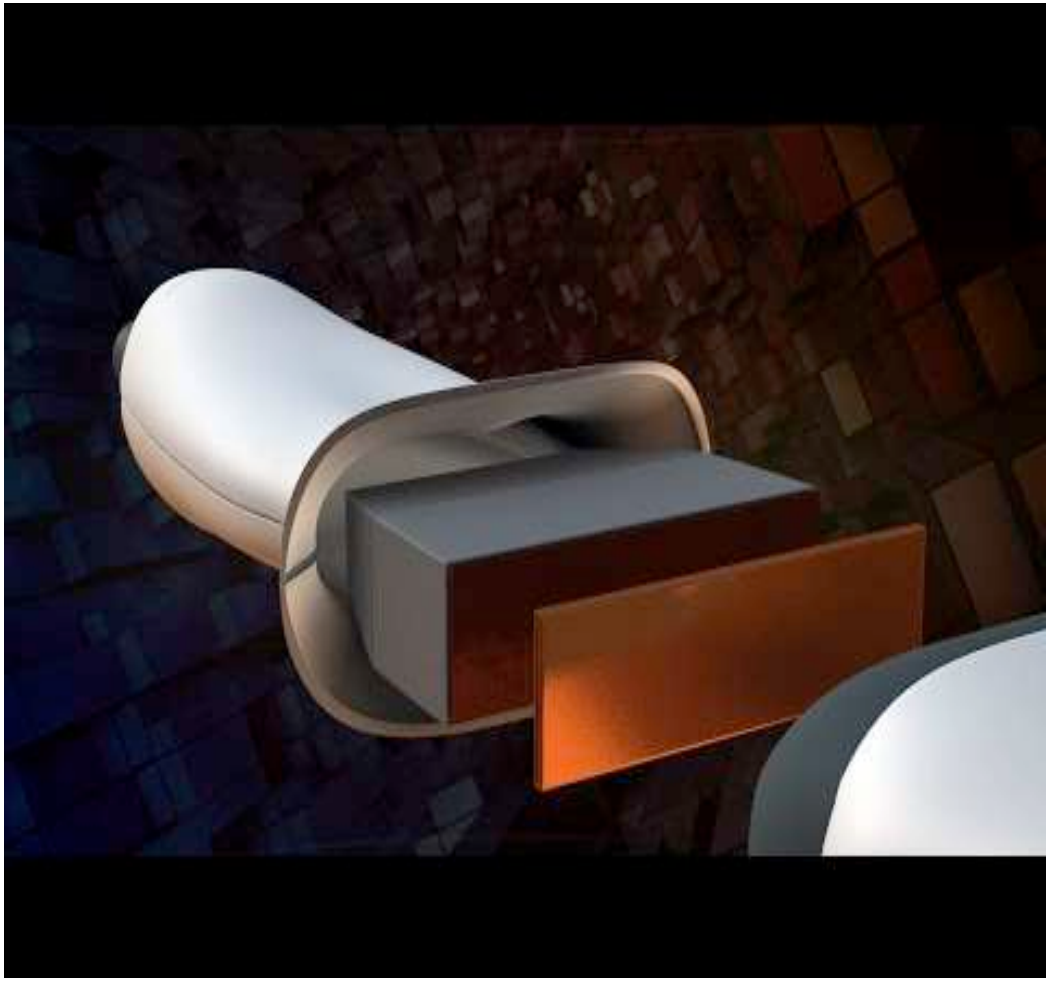
Answer

λ= 2.69 m
v = 343 m/s
$v = \lambda f$
v/λ = f
343 m/s/2.69 m = 127.5 Hz

T = 1/f
T = 1/127.5 Hz
T = 0.007843 s

Therefore the frequency is 128 Hz, and the period is 7.84×10^{-3} s

Applications of Sound Waves



Sound Applications

- Sonar
- Lung flute
- High intensity focussed ultrasound
- Echolocation
- LRAD
- MIST
- Cymatics