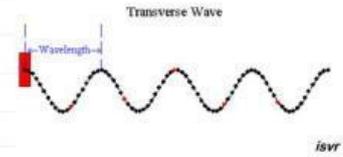


Mechanical waves

- _____ a disturbance that carries energy through matter or space without transferring matter.
- _____: waves that travel in a physical medium
- Example of mechanical waves: _____
- _____ a single bump or disturbance that travels throughout the medium
- _____ a train of wave pulses that results from continuous disturbance of the particles in a medium at a constant rate.



Types of waves

waves

A wave that disturbs the particles in the medium perpendicular to the direction of the wave's travel

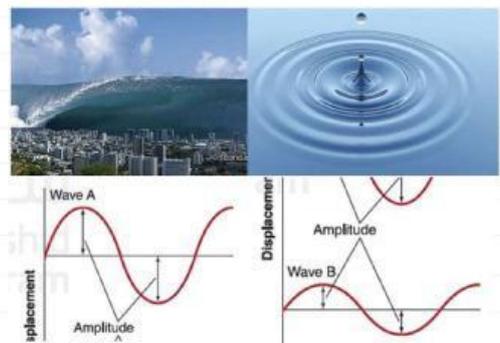
a wave that disturbs the particles in a medium parallel to the direction of the wave's travel

the medium's particles follow a circular path that is at times parallel to the direction of travel and at other times perpendicular.

Wave properties

1. Amplitude(A)(m)

Amplitude: it is the greatest displacement from the equilibrium position
 Which wave will have a bigger amplitude ?



Section 1.2 wave properties

Wave properties

2. Energy

Waves with bigger amplitudes transfer more energy.

For the same speed, The energy transferred by a wave is proportional to the square of the amplitude of the wave.

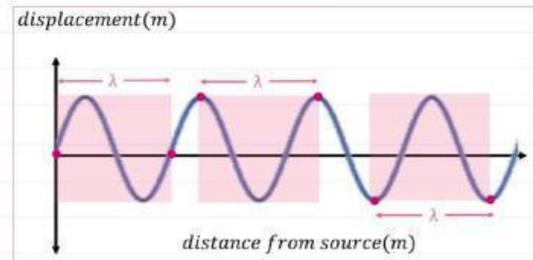
If we double the amplitude of the wave, by which factor will the energy of the wave increase?

3. wavelength (λ) (m)

Wavelength: the shortest distance between points where the wave pattern repeats itself

Trough: the lowest point in a transverse wave

Crest: the highest point in a transverse wave



4. Speed (v) (m/s)

- the speed of a wave is calculated the same way it is calculated for linear motion

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

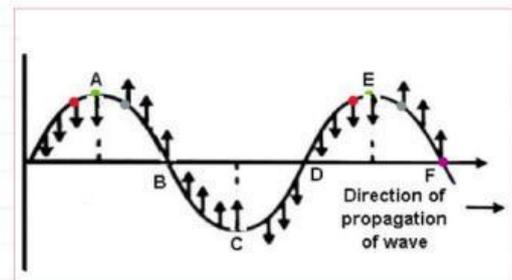
- wave speed **does not depend on amplitude, frequency or wavelength. Speed depends only on the matter and temperature of the medium** through which the waves move in

Material	Speed of Sound (m/s)
Air	343
Wood	3960
Water	1493

Temperature (°C)	Speed of Sound in Air (m/s)
-1.0	330.4
20	343.0
45	358.0

5. phase

- Any two points on a wave that are one or more whole wavelengths apart are said to be **in phase**
- Particles in a medium are said to be **in phase** when they have the **same displacement from the equilibrium point and the same velocity**.
- Particles with opposite displacements from the equilibrium position and opposite velocities are **180 degrees out of phase**
- A crest and a trough, for example are 180 degrees out of phase



6. Period (T) (s) and frequency (f) (Hz):

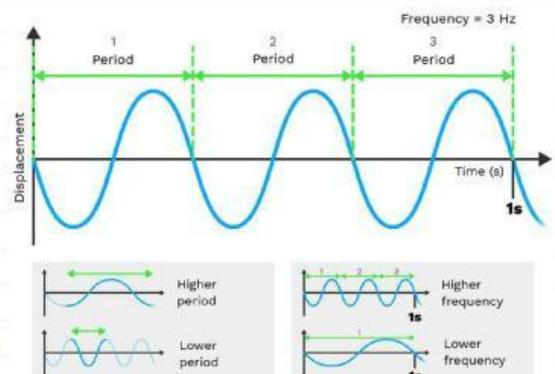
- Period**: the time it takes for the motion to complete one cycle.
- Frequency**: the number of complete oscillations a point on a wave makes each second.
- The unit of frequency is Hz , where $1 Hz = 1/s = s^{-1}$

Frequency of a Wave

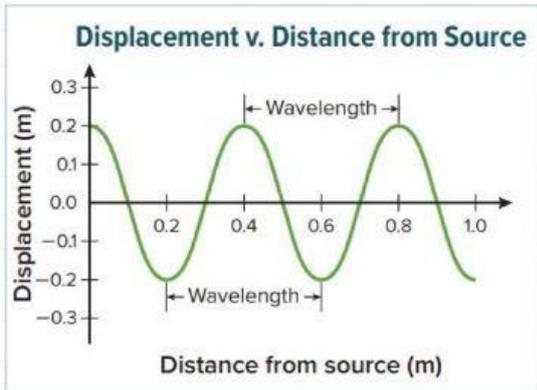
The frequency of a wave is equal to the reciprocal of the period.

$$f = \frac{1}{T}$$

- depend only on **the wave's source**. They do not depend on the wave's speed or the medium.

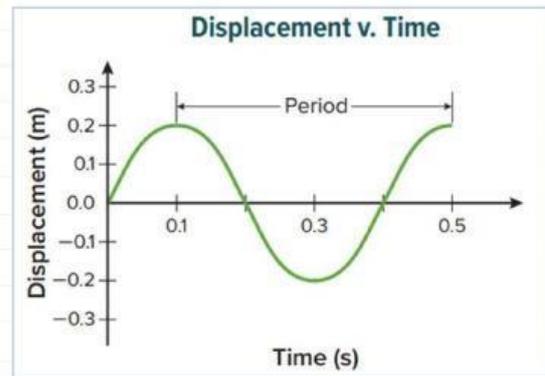


Graphing waves



From this graph you can extract the following properties:

1. Amplitude
2. Wavelength



From this graph you can extract the following properties:

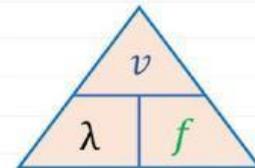
1. Amplitude
2. period

Calculating wavelength

Wavelength

The wavelength of a wave is equal to the velocity divided by the frequency.

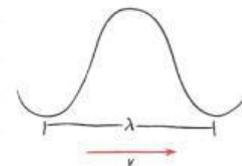
$$\lambda = \frac{v}{f}$$



EXAMPLE Problem 3

A sound wave has a frequency of 192 Hz and travels the length of a football field, 91.4 m, in 0.271 s.

- a. What is the speed of the wave?
- b. What is the wavelength of the wave?
- c. What is the period of the wave?
- d. If the frequency were changed to 442 Hz, what would be the new wavelength and period?



homework

14. A sound wave produced by a clock chime is heard 515 m away 1.50 s later.
 - a. Based on these measurements, what is the speed of sound in air?
 - b. The sound wave has a frequency of 436 Hz. What is the period of the wave?
 - c. What is its wavelength?

16. What is the speed of a periodic wave disturbance that has a frequency of 3.50 Hz and a wavelength of 0.700 m?

17. How does increasing the wavelength by 50 percent affect the frequency of a wave on a rope?

19. Five wavelengths are generated every 0.100 s in a tank of water. What is the speed of the wave if the wavelength of the surface wave is 1.20 cm?

20. A periodic longitudinal wave that has a frequency of 20.0 Hz travels along a coiled spring toy. If the distance between successive compressions is 0.600 m, what is the speed of the wave?

21. How does the frequency of a wave change when the period of the wave is doubled?

22. Describe the change in the wavelength of a wave when the period is reduced by one-half.

23. If the speed of a wave increases to 1.5 times its original speed while the frequency remains constant, how does the wavelength change?

24. CHALLENGE A hiker shouts toward a vertical cliff as shown. The echo is heard 2.75 s later.

- a. What is the speed of sound of the hiker's voice in air?
- b. The wavelength of the sound is 0.750 m. What is its frequency?
- c. What is the period of the wave?

