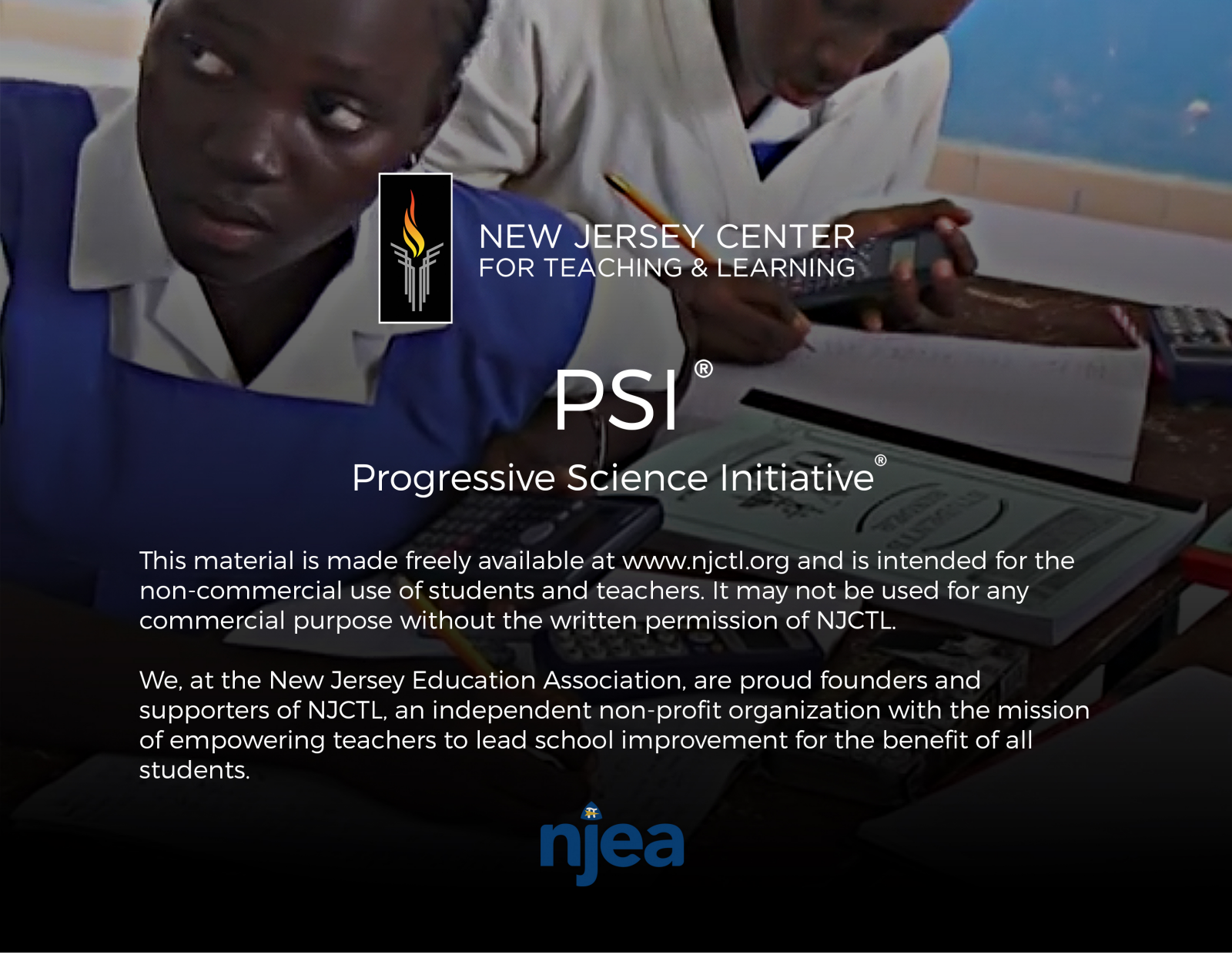


NEW JERSEY CENTER
FOR TEACHING & LEARNING

PSI®

Progressive Science Initiative®

We, at the New Jersey Education Association, are proud founders and supporters of NJCTL, an independent non-profit organization with the mission of empowering teachers to lead school improvement for the benefit of all students.

njea

NEW JERSEY CENTER
FOR TEACHING & LEARNING

AP Physics 1

Waves

2017-07-20

www.njctl.org

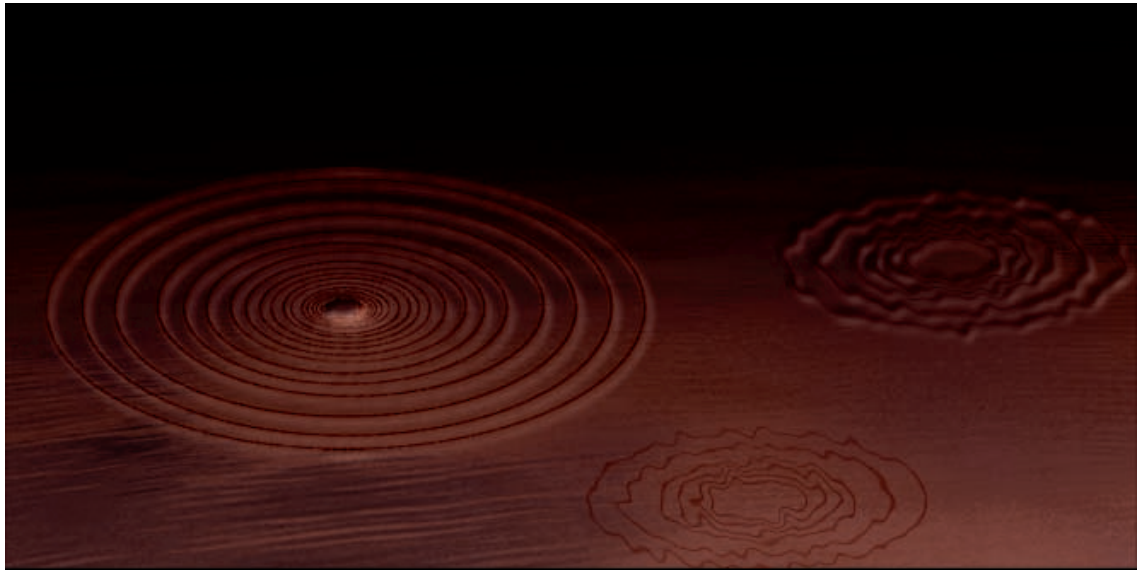
Table of Contents

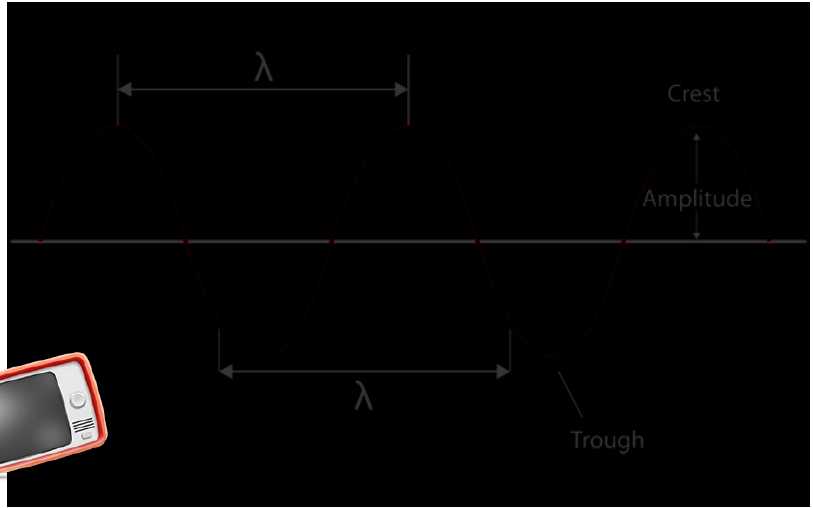
Click on the topic to go to that section

Wave Motion

Return to Table of Contents

Wave Motion

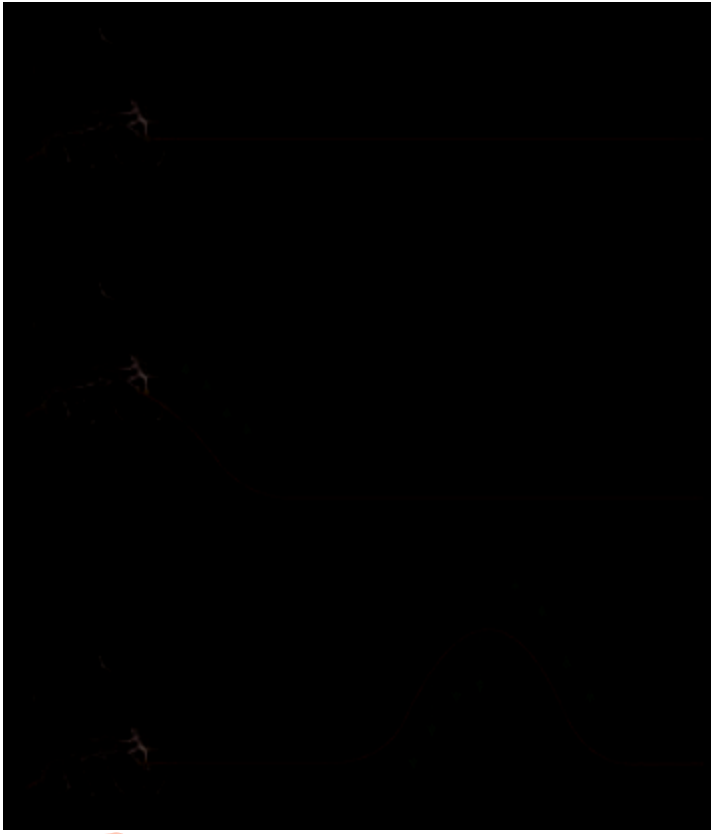




A wave travels along its medium, but the individual particles just move up and down.

Wave Motion

All types of traveling waves transport energy.



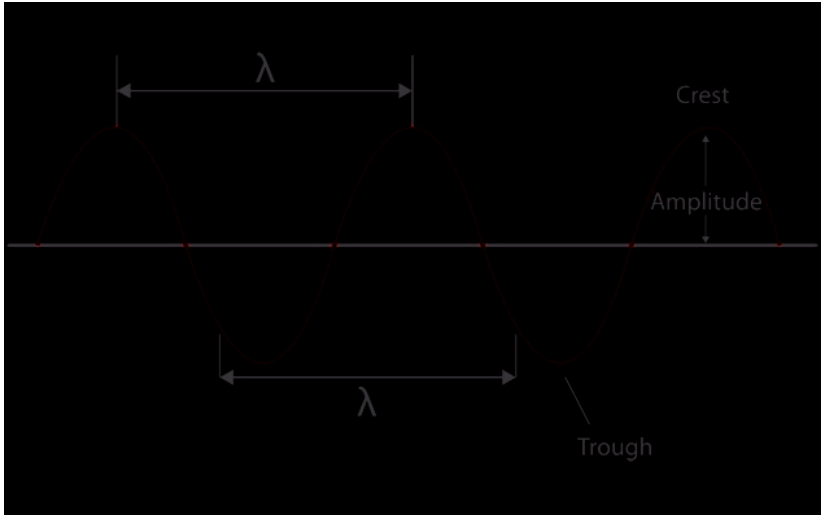
Study of a single wave pulse shows that it is begun with a vibration and transmitted through internal forces in the medium.

Continuous waves start with vibrations too. If the vibration is SHM, then the wave will be sinusoidal.

Wave Motion

Wave characteristics:

- Amplitude, A
- Wavelength, λ
- Frequency f and period T
- Wave velocity



Wave Motion

Wave velocity is the velocity at which wave crests (or any other part of the wave) moves.

A wave crest travels a distance of one wavelength, λ, in one period, T.

$$v = \frac{\Delta x}{\Delta t} = \frac{\lambda}{T}$$

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

Wave velocity is: $v = \lambda f$

1 What is the wave speed if the period of a wave is 4.0 seconds and the wavelength is 1.8 m?

- A 0.45 m/s
- B 0.90 m/s
- C 1.4 m/s
- D 1.9 m/s
- E I need help

Answer

2 A fisherman noticed that a float makes 30 oscillations in 15 seconds. The distance between to consecutive crests is 2.0 m. What is the wave speed?

- A 2.0 m/s
- B 4.0 m/s
- C 15 m/s
- D 24 m/s
- E I need help

Answer

3 What is the wavelength of a wave traveling with a speed of 6 m/s and a period of 3 s?

- A 2 m
- B 6 m
- C 9 m
- D 18 m
- E I need help

Answer

Wave Motion

The velocity of a wave depends on the medium through which it is traveling.

The velocity of a wave on a stretch string is related to the tension force in the string and the mass per unit length of the string.

$$v = \sqrt{\frac{F_t}{\mu}}$$

Where F_T is the tension in the string and μ is the mass per unit length (m/L).

4 What happens to the speed of a wave on a string if the tension of the string is increased by a factor of nine?

- ○ A It is decreased by a factor of 3.
- ○ B It is decreased by a factor of 9.
- ○ C It is increased by a factor of 3.
- ○ D It is increased by a factor of 9.
- ○ E I need help

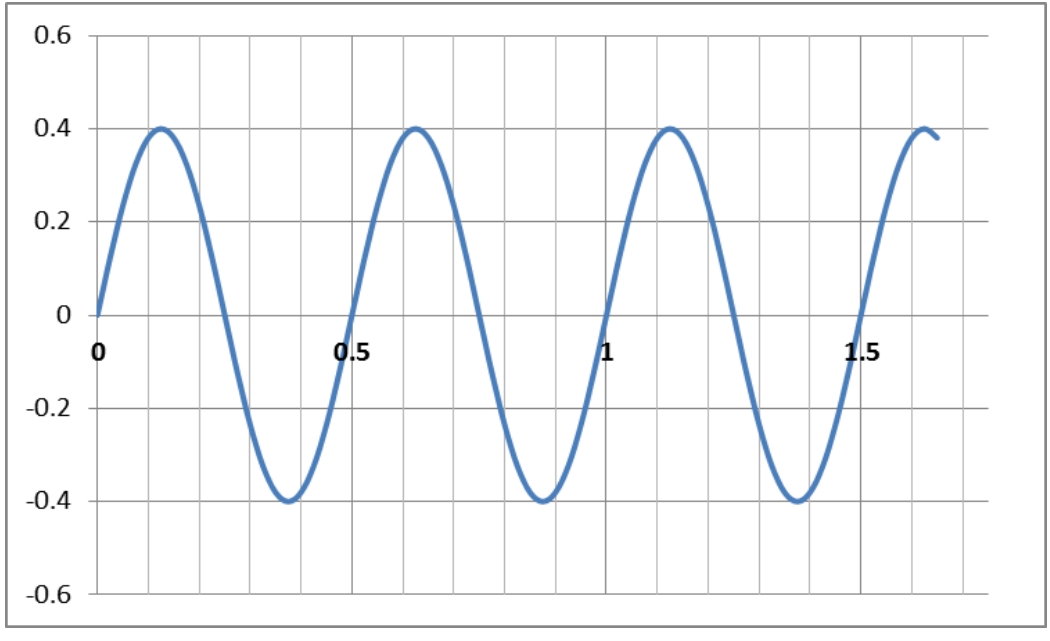
Answer

5 What happens to the speed of a wave on a string if the mass per unit length of the string is increased by a factor of nine?

- A It is decreased by a factor of 3.
- B It is decreased by a factor of 9.
- C It is increased by a factor of 3.
- D It is increased by a factor of 9.
- E I need help

Answer

6 A wave with a wavelength of 30 cm is traveling on a string. The graph below shows the position as a function of time for a point on the string. What is the average speed of the point?



- A 3.2 m/s
- B 0.3 m/s
- C 0.5 m/s
- D 0.6 m/s
- E I need help

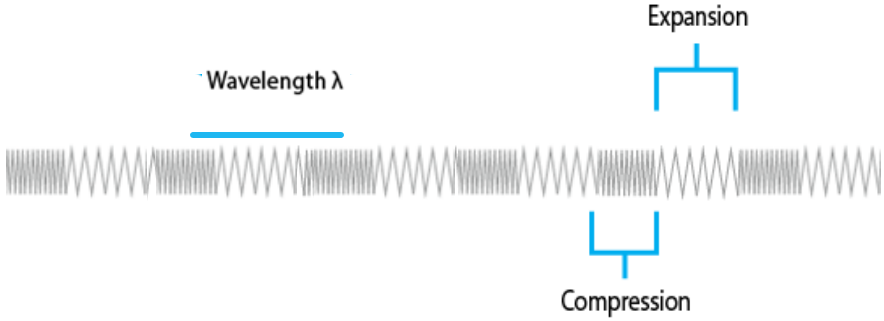
Answer

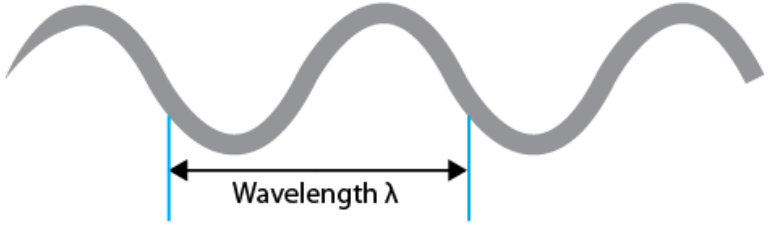
Types of Waves

Demo

Return to Table of Contents

Types of Waves: Transverse and Longitudinal

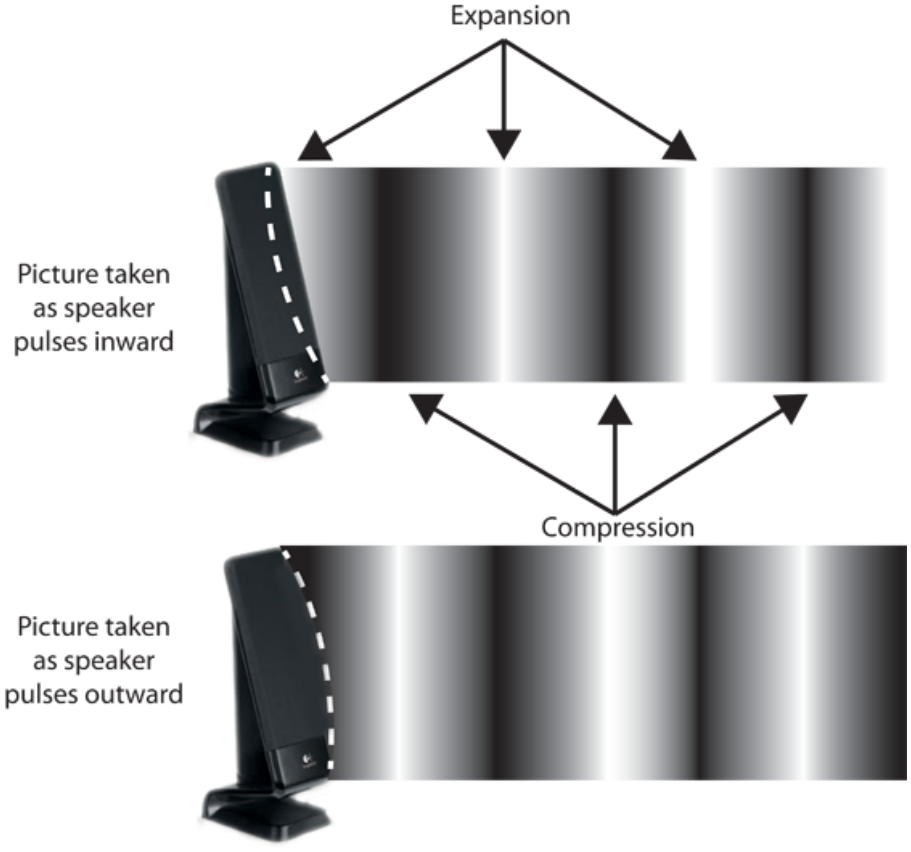




The motion of particles in a wave can either be perpendicular to the wave direction (transverse) or parallel to it (longitudinal).

Types of Waves: Transverse and Longitudinal

Sound waves are longitudinal waves:

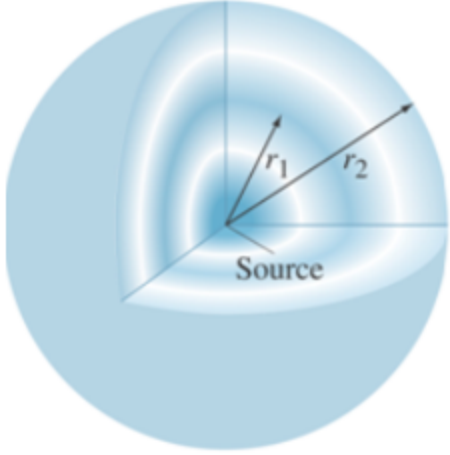


Energy Transportation

The energy transported by a wave is proportional to the square of the amplitude.

The intensity, I, of a wave is defined as the power transported across a unit area perpendicular to the direction of energy flow.

$$I = \frac{Power}{Area} = \frac{P}{4\pi r^2}$$

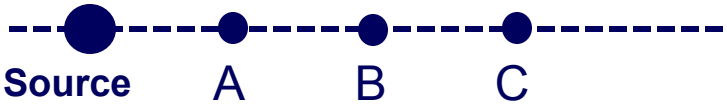


So Intensity is inversely proportional to the square of the distance from the source.

$$I \propto \frac{1}{r^2}$$

7 At point C the intensity of a wave is I_0.
What is the intensity at point A?

- A I_0
- B $3I_0$
- C $6I_0$
- D $9I_0$
- E I need help

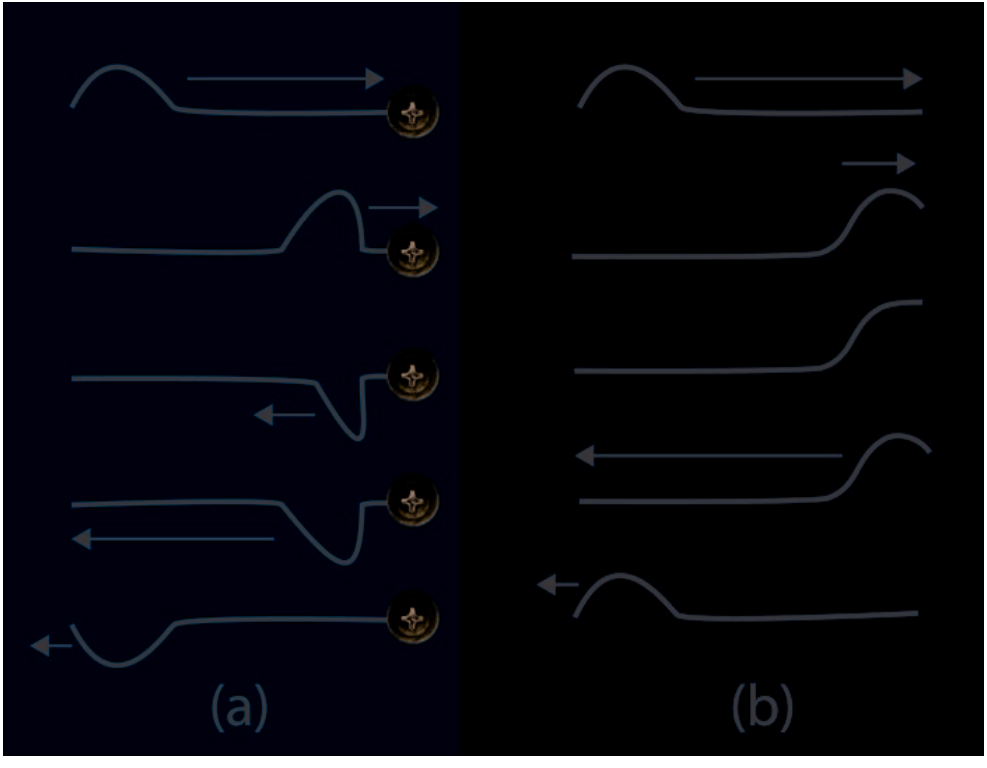


Answer

Interference

Return to Table of Contents

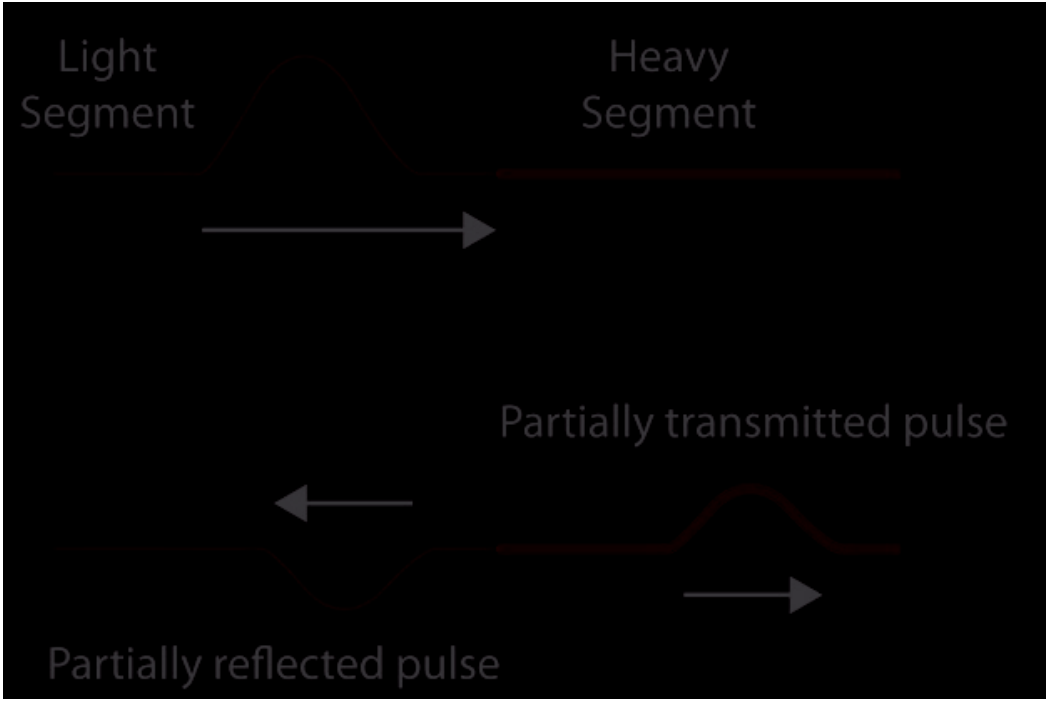
Reflection and Transmission of Waves



A wave reaching the end of its medium, but where the medium is still free to move, will be reflected (b), and its reflection will be upright.

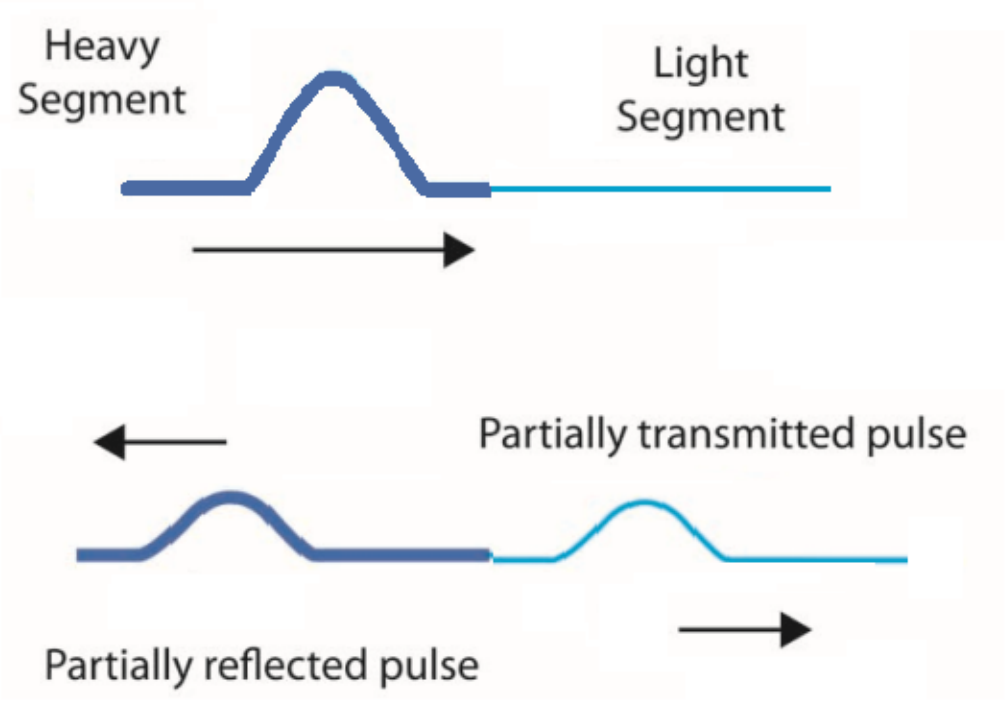
A wave hitting an obstacle will be reflected (a), and its reflection will be inverted.

Reflection and Transmission of Waves



A wave encountering a denser medium will be partly reflected and partly transmitted; if the wave speed is less in the denser medium, the wavelength will be shorter.

Reflection and Transmission of Waves

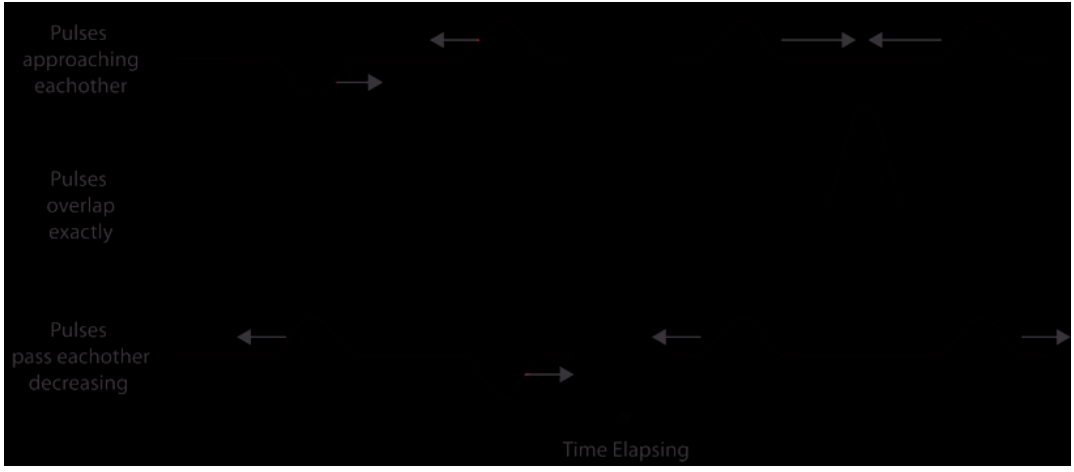


A wave encountering a lighter medium will be partly reflected and partly transmitted; if the wave speed is greater in the denser medium, the wavelength will be longer.

Interference; Principle of Superposition

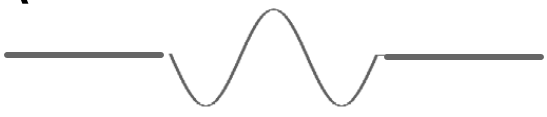
The superposition principle says that when two waves pass through the same point, the displacement is the arithmetic sum of the individual displacements.

In the figure below, (a) exhibits destructive interference and (b) exhibits constructive interference.



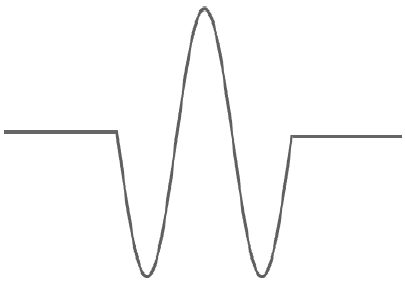
8 Two students hold a string tight and create wave pulses on the string as shown below. What will the string look like when the pulses overlap?

A

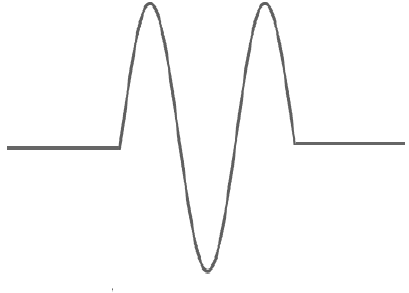


B

C



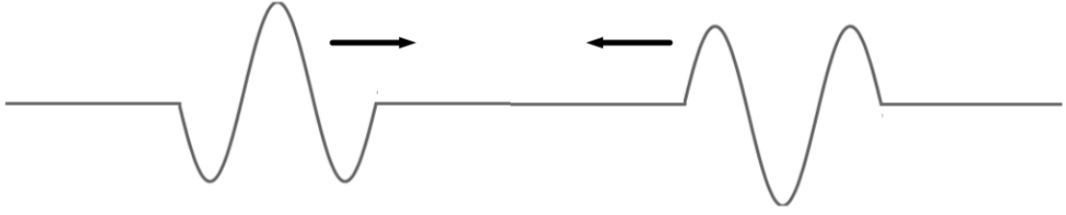
D



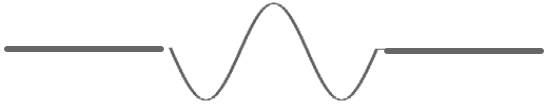
E I need help

Answer

9 Two students hold a string tight and create wave pulses on the string as shown below. What will the string look like when the pulses overlap?

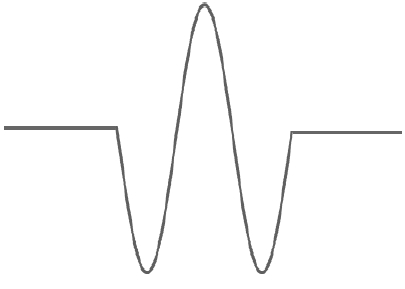


A

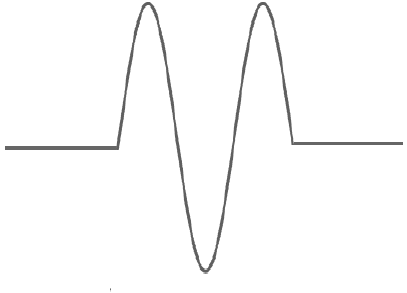


B

C



D

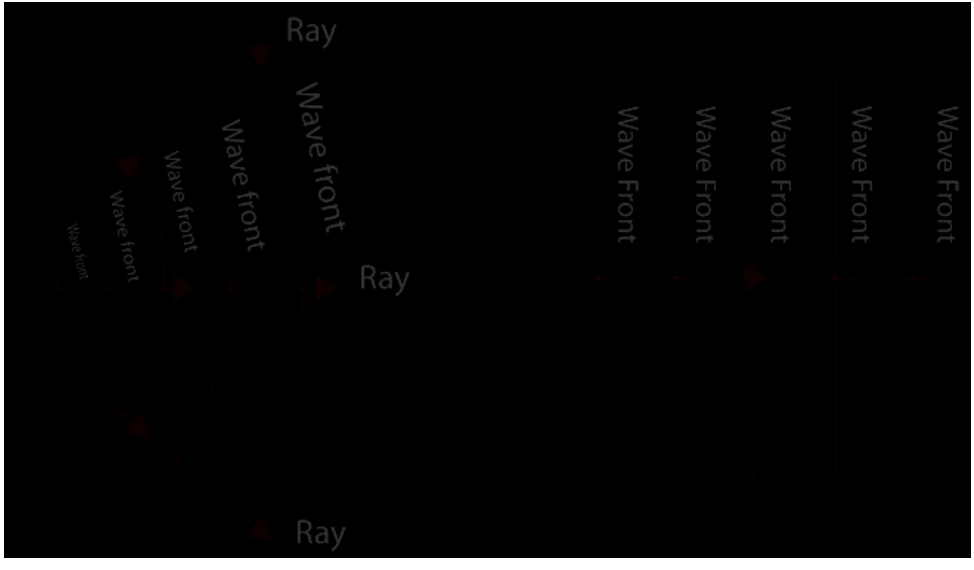


E I need help

Answer

Reflection and Transmission of Waves

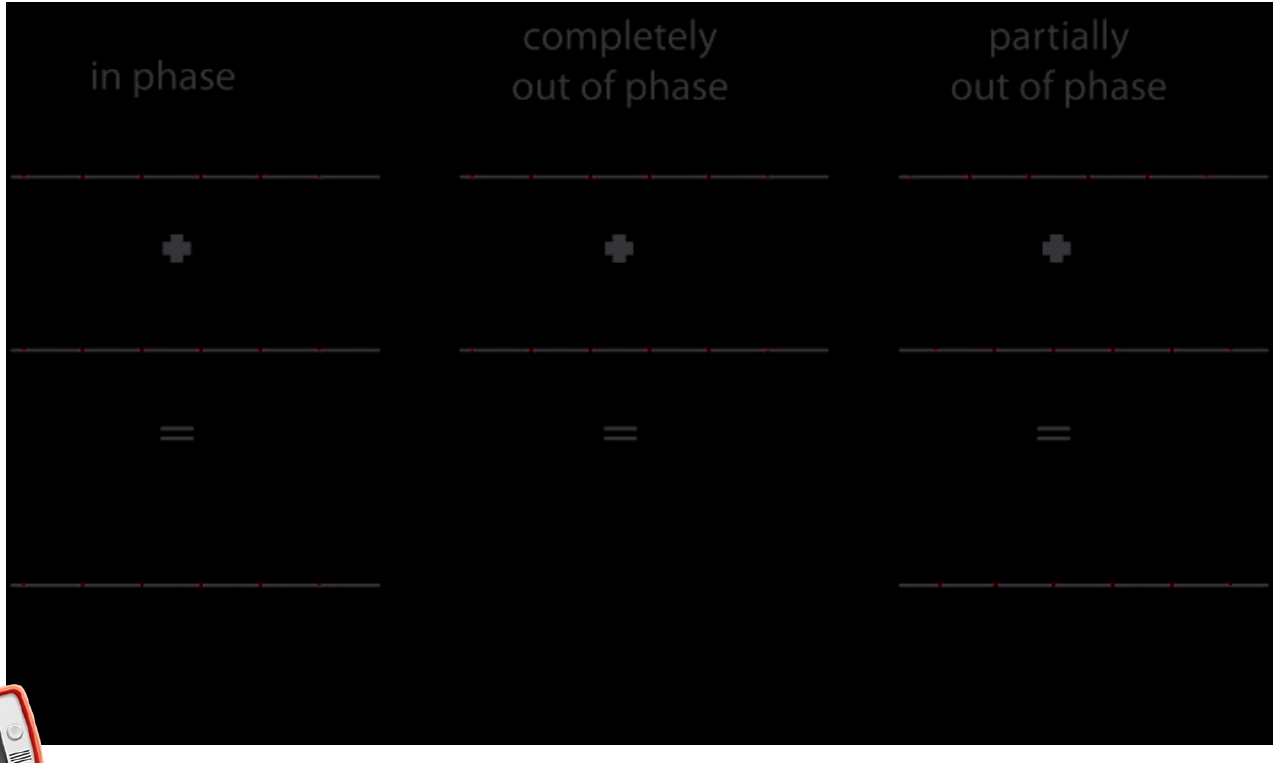
Two- or three-dimensional waves can be represented by wave fronts, which are curves of surfaces where all the waves have the same phase.



Lines perpendicular to the wave fronts are called rays; they point in the direction of propagation of the wave.

Interference; Principle of Superposition

These figures show the sum of two waves. In (a) they add constructively ; in (b) they add destructively ; and in (c) they add partially destructively .



10 What is the result at an oscillating point if two waves reach this point one half of a wavelength apart?

- A Constructive interference
- B Destructive interference
- C Partially destructive interference
- D I need help

Answer

11 What is the result at an oscillating point if twowaves reach this point two full wavelengths apart?

- A Constructive interference
- B Destructive interference
- C Partially destructive interference
- D I need help

Answer

12 What is the result at an oscillating point if twowaves reach this point one quarter of a wavelength apart?

- A Constructive interference
- B Destructive interference
- C Partially destructive interference
- D I need help

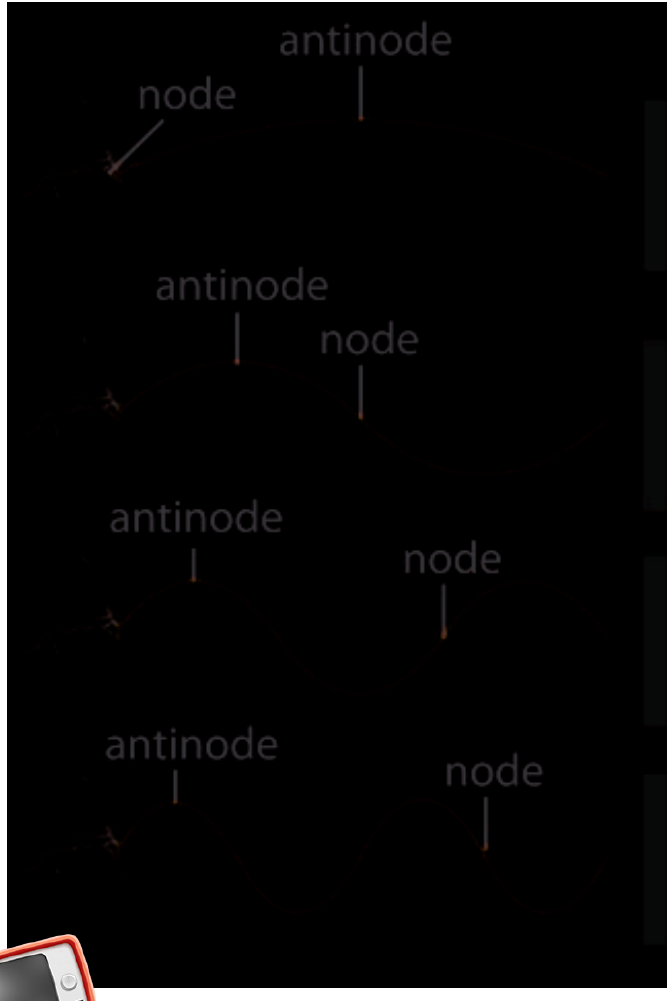
Answer

Standing Waves on a String

Demo

Return to Table of Contents

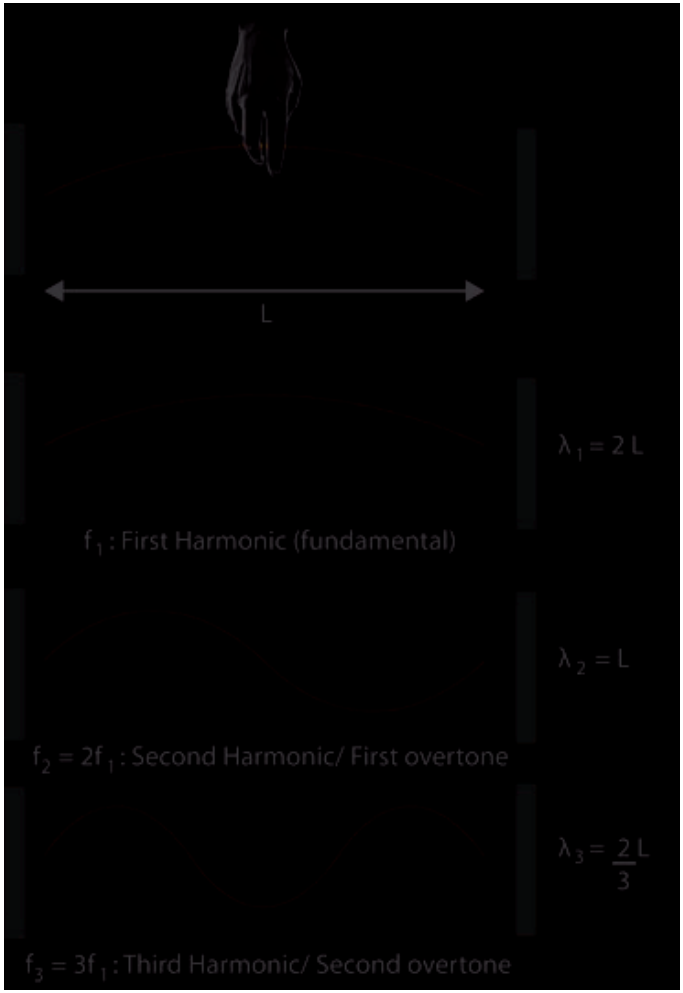
Standing Waves; Resonance



Standing waves occur when both ends of a string are fixed. In that case, only waves which are motionless at the ends of the string can persist.

There are nodes, where the amplitude is always zero, and antinodes, where the amplitude varies from zero to the maximum value.

Standing Waves; Resonance



The frequencies of the standing waves on a particular string are called resonant frequencies.

They are also referred to as the fundamental and harmonics.

Standing Waves; Resonance

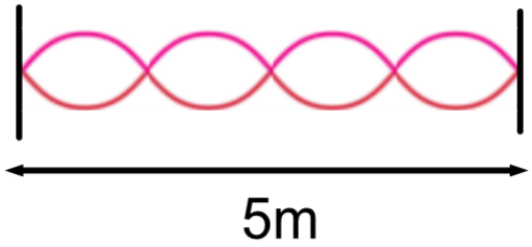
The wavelengths and frequencies of standing waves are:

$$\lambda_n = \frac{2L}{n}$$

$$f_n = \frac{v}{\lambda_n} = \frac{v}{\frac{2L}{n}} = n\frac{v}{2L} = nf_1$$

$$n = 1, 2, 3, \ldots$$

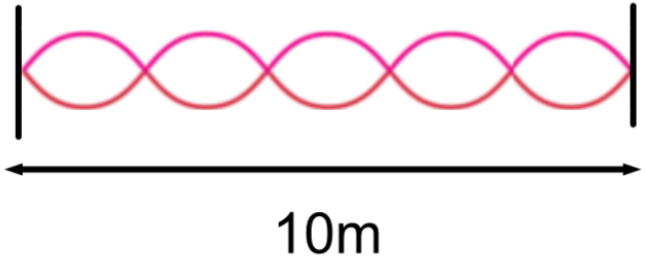
13 Wave is the wavelength of the wave shown below?



- ○ 2.0 m
- ○ 2.5 m
- ○ 5.0 m
- ○ 10 m
- ○ I need help

Answer

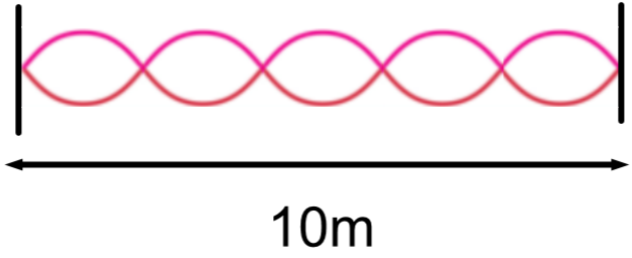
14 Wave is the wavelength of the wave shown below?



- A 2.0 m
- B 2.5 m
- C 4.0 m
- D 5.0 m
- E I need help

Answer

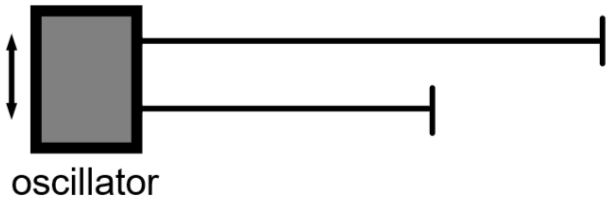
15 If the speed of the wave is 8m/s, what is the frequency of this wave?



- A 2 Hz
- B 4 Hz
- C 5 Hz
- D 10 Hz
- E I need help

Answer

16 Two strings of the same material are cut to two different lenghts and attached to an oscillator. The first string has a length of L and the second string has a length of two thirds of L. The first time a standing wave is achieved in the first string the frequency is 30Hz. What will the frequency be the first time a standing wave is achieved in the second string?



- A 20 Hz
- B 30 Hz
- C 45 Hz
- D 90 Hz
- E I need help

Answer

Summary

Vibrating objects are sources of waves, which may be either a pulse or continuous.

Wavelength: distance between successive crests

Frequency: number of crests that pass a given point per unit time.

Amplitude: maximum height of crest.

Wave velocity: $v = \lambda f$

For a wave on a string:

$$v = \sqrt{\frac{F_t}{\mu}}$$

Summary

Transverse wave: oscillations perpendicular to direction of wave motion.

Longitudinal wave: oscillations parallel to direction of wave motion.

Summary

When two waves pass through the same region of space, they interfere. Interference may be either constructive or destructive.

Standing waves can be produced on a string with both ends fixed. The waves that persist are at the resonant frequencies.

$$\lambda = \frac{2L}{n}$$

Nodes occur where there is no motion; antinodes where the amplitude is maximum.

Waves refract when entering a medium of different wave speed, and diffract around obstacles.