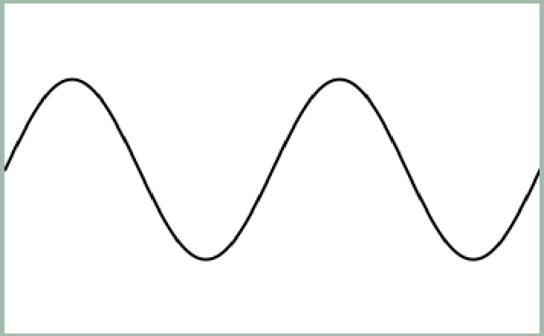
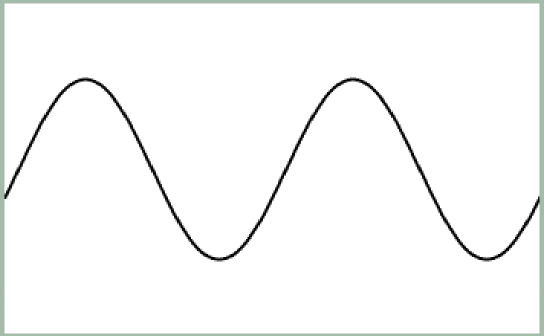
This is pages 14 – 16.

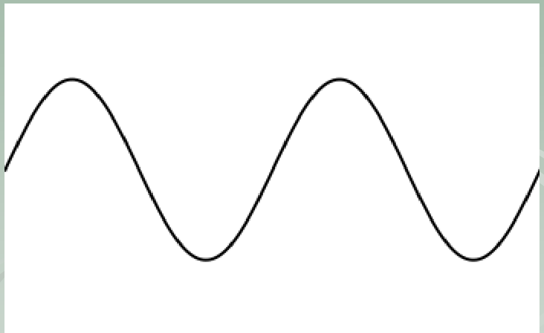
Please EMAIL with any questions.

Standing Waves

- Traveling Wave – a wave that transmits energy without transmitting mass





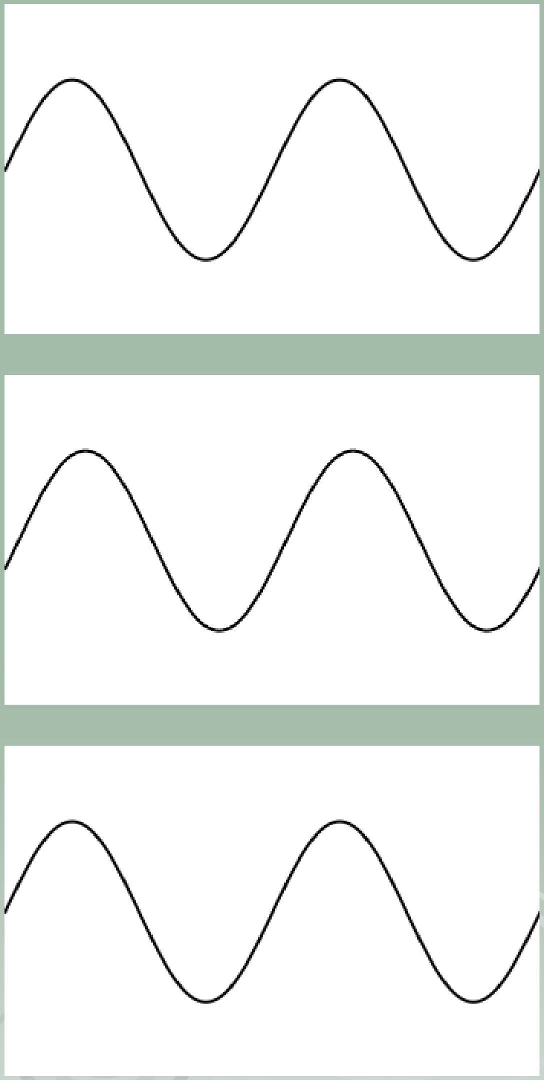


Just read, don’t write anything

Standing Waves

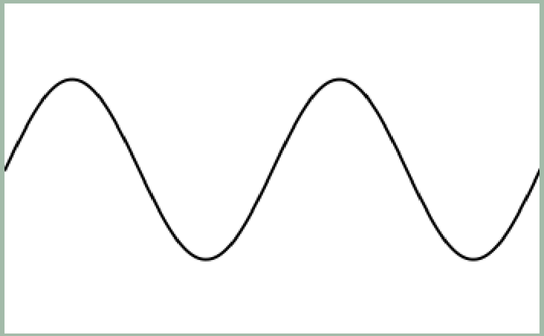
- Standing Wave – a wave produced when two identical waves travel in opposite directions in the same medium
  - The wave does not transmit energy

Just read, don't write anything

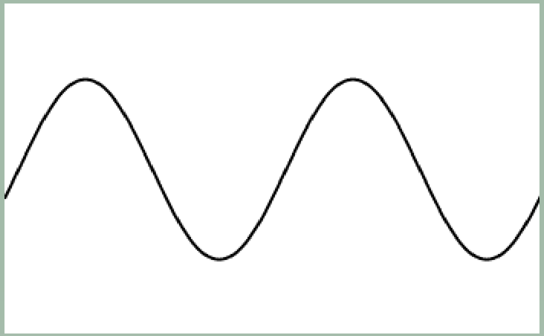


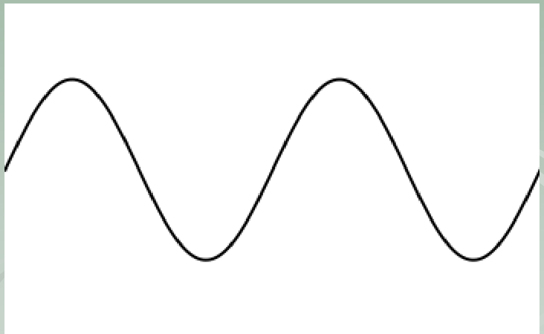
Standing Waves

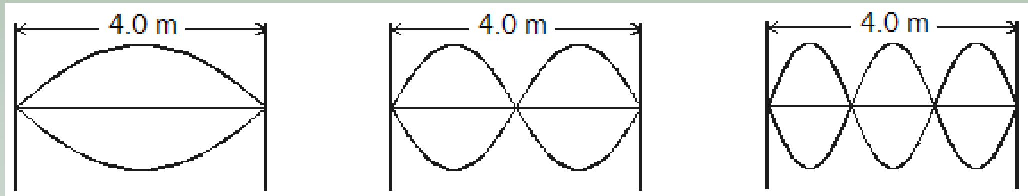
(A regular wave is a traveling wave. You can see it move to the side. Draw it as a regular sin curve)



(A standing wave does not appear to move sideways. It "stands" still and alternates crest and trough. Drawn with crest trough "bubbles")

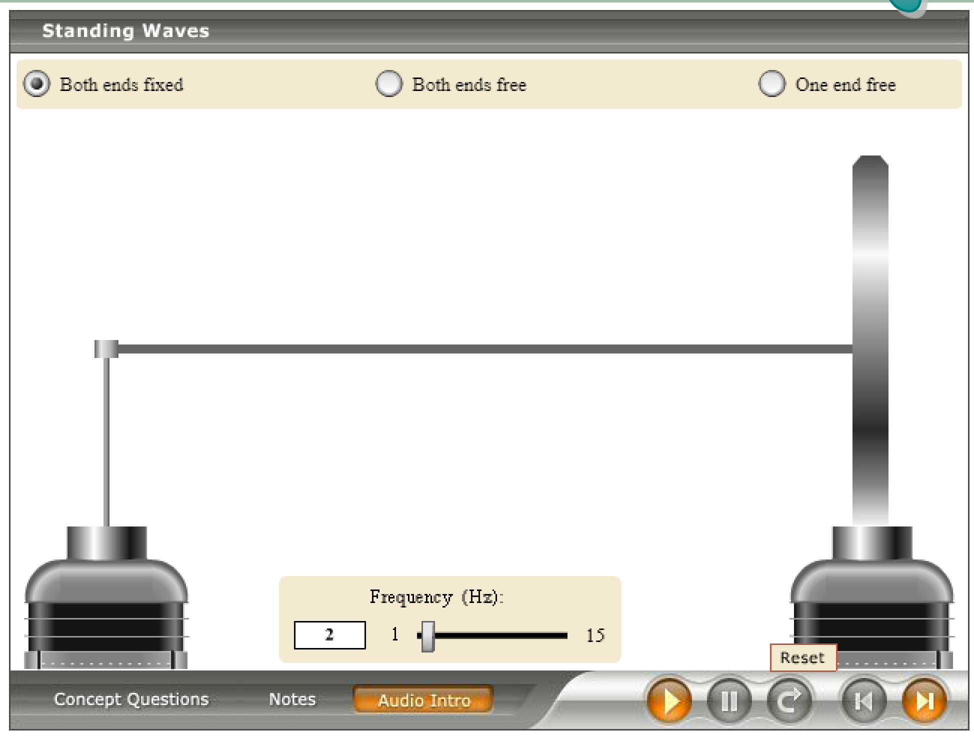






Try running the simulation. You may need to enable flash player. After the audio intro click play. Then increase the frequency to see how the wave changes.

Standing Waves



https://www.wiley.com/college/halliday/0470469080/simulations/sim27/sim27.html

Standing Waves



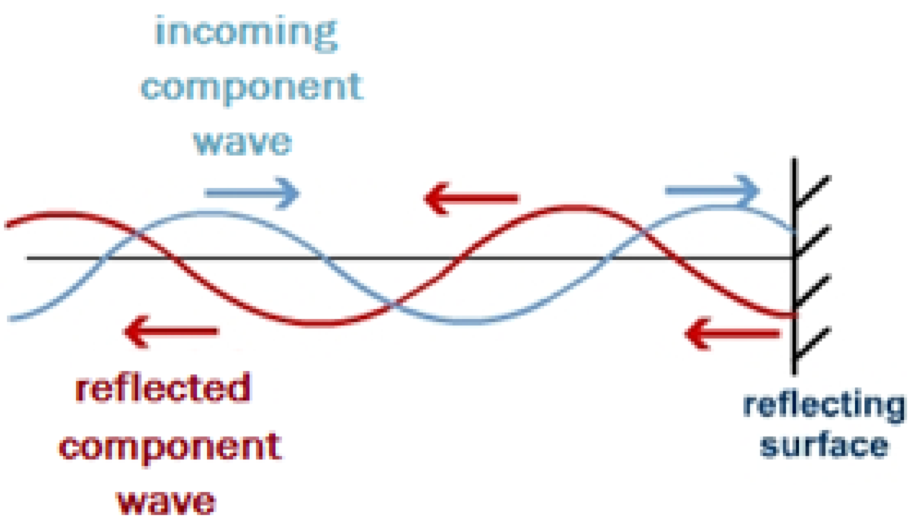



They created a standing wave by making a trench in the sand that water rushes in and out of.

Standing Waves

Formation of Standing Waves

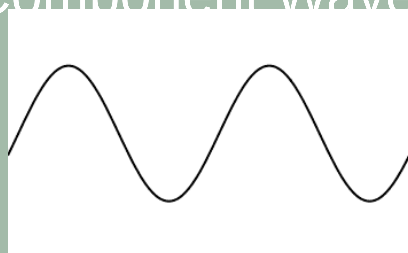
1. A traveling wave moving in one direction in a medium is reflected off the end of the medium.
2. This sends a reflected wave traveling in the opposite direction in the medium. This second wave is (nearly) identical with the first traveling wave. It has the same frequency, same wavelength, almost same amplitude.



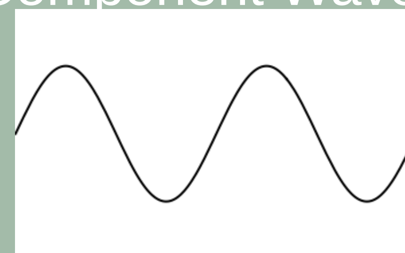
3. The two identical component waves traveling in opposite directions interfere with each other creating the standing wave. The standing wave is the **resultant** wave. Its amplitude at any point is the superposition of the components' amplitudes.

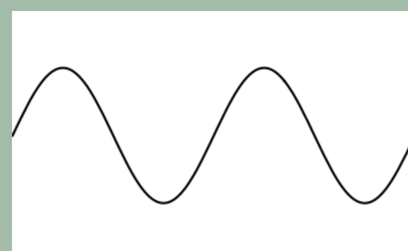
Standing Waves

Component Wave



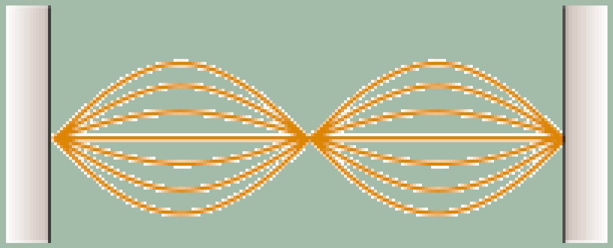
Component Wave





- Standing (Stationary) Wave - The resultant wave formed when two waves of equal amplitude and frequency traveling in opposite directions in the same medium interfere.

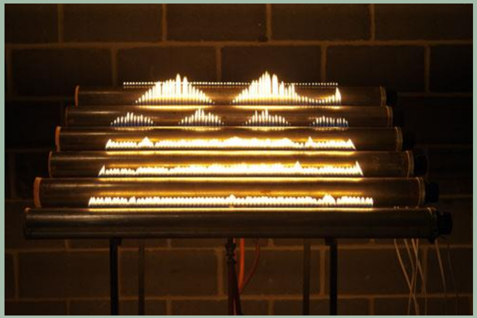
Standing Waves

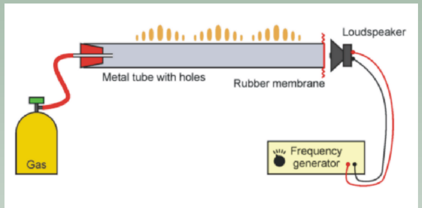


- Node: location of constant complete destructive interference
  - Points are out of phase
- Anti-Node: location of maximum constructive interference
  - Points are in phase

(One crest-trough "bubble" is one antinode.)

Ruben's Tube

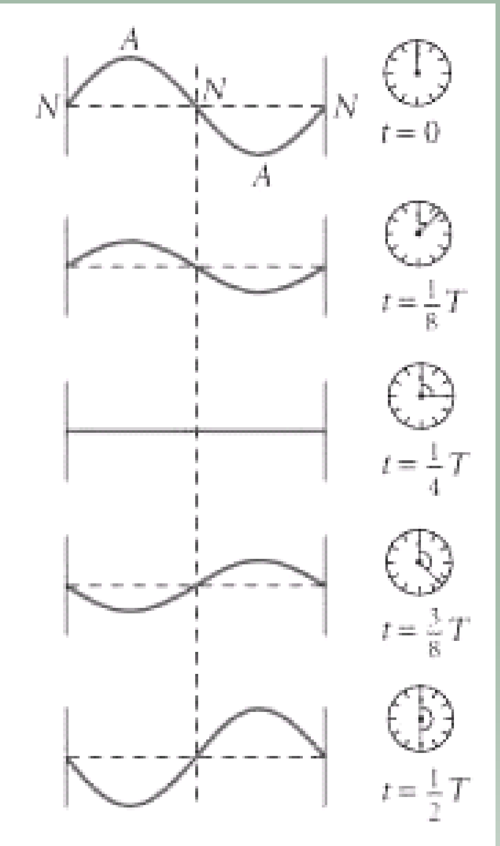




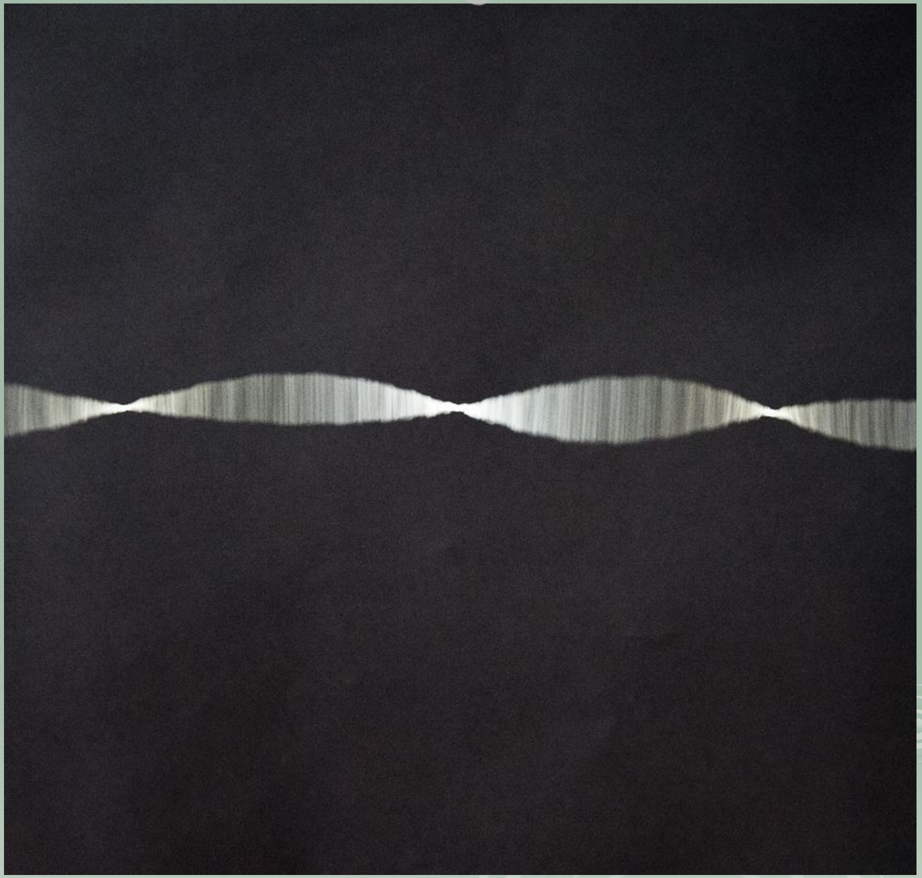
https://www.youtube.com/watch?v=ynqzeIYA7Iw

Watch the video.

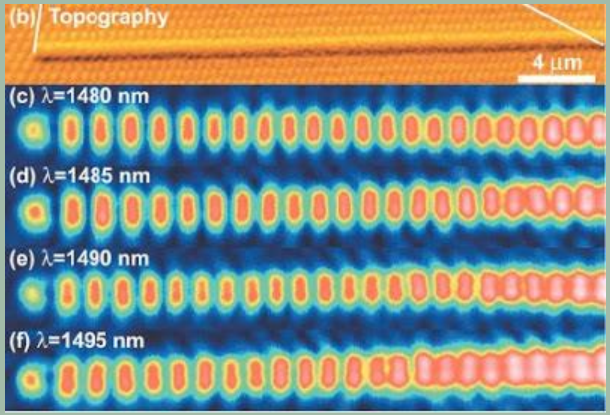
Standing Waves



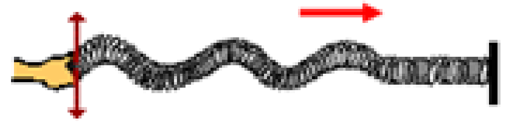
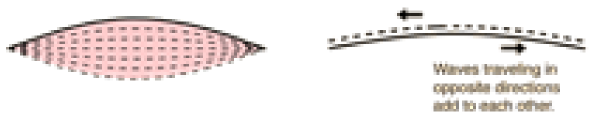
This graphic shows what the standing wave looks like after each fraction of a period. Notice that you never see the two component traveling waves but only see the resultant standing wave.



Standing Waves

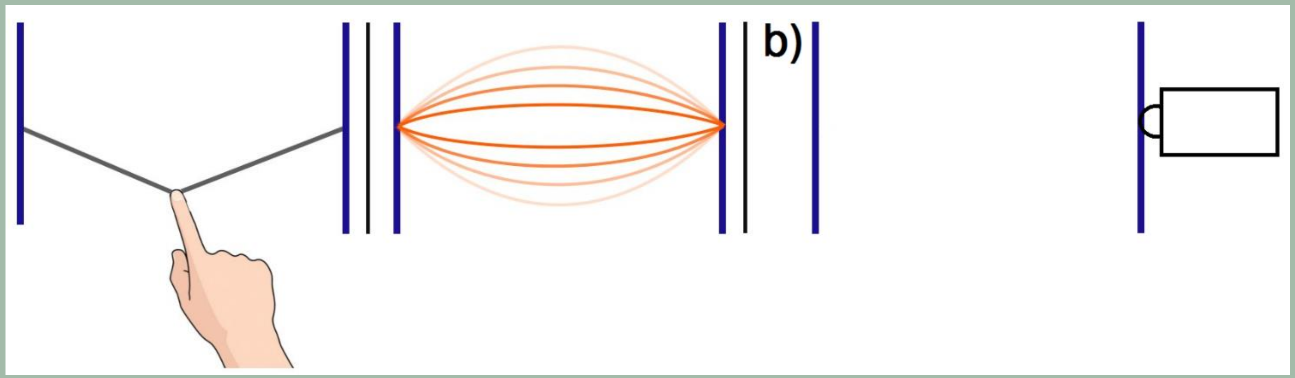


	Sound	Light
Node	Silent	Dark
Anti-node	Loud	Bright

	Traveling (Progressive) Wave	Standing (Stationary) Wave
		
1. Energy	Energy is transferred by the wave.	Energy is not transferred by the wave, but it does have energy stored in it.
2. Amplitude	All points on the wave have the same amplitude so we say it has *fixed amplitude* (provided energy is not dissipated.)	All points on the wave have different amplitude so we say it has *variable amplitude*. The maximum amplitude is at the antinodes and is 0 at the nodes.
3. Wavelength	Equal to the shortest distance along the wave between any two points that are in phase.	Same as the wavelength of the component waves. Equal to twice the distance between any two consecutive nodes (or antinodes).
4. Frequency	All particles oscillate in SHM with the same frequency.	All particles oscillate in SHM with the same frequency as the component waves.
5. Phase and phase difference	All points within one wavelength have a different phase. Thus, all phase differences are possible.	All points in one section between two consecutive nodes (or antinodes) are moving in phase. All points in the next section are 180º out of phase with all points in this section. Thus, the only possible phase differences are 0º and 180º.

Read the information.

Standing Waves

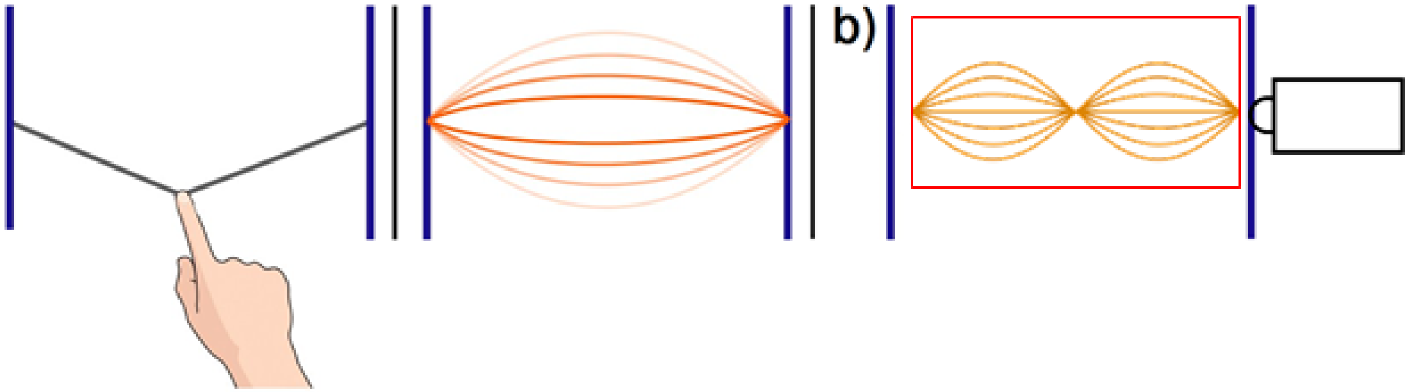


The diagram above shows the first harmonic (fundamental) standing wave vibrating at 73 Hz on a string that is 0.85 meter long.

- Determine the speed of the waves on the string.

- Sketch the standing wave that results when the string is vibrated at twice this fundamental frequency.
- Determine the speed of the waves on the string when it is vibrated at this new frequency.

Standing Waves



1. The diagram above shows the first harmonic (fundamental) standing wave vibrating at 73 Hz on a string that is 0.85 meter long.

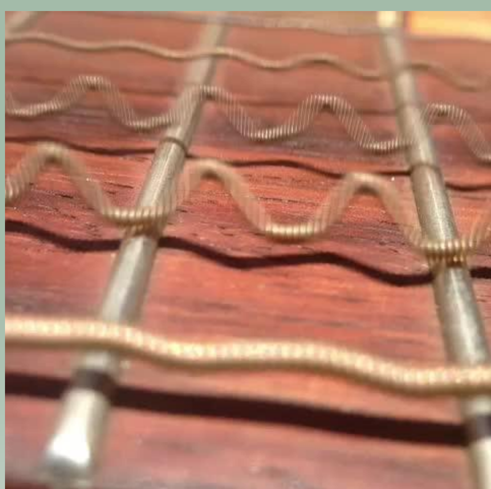
   a) Determine the speed of the waves on the string.

      $v = f\lambda$
      $v = (73\text{ Hz})(1.7\text{ m})$
      $v = 124\text{ m/s}$

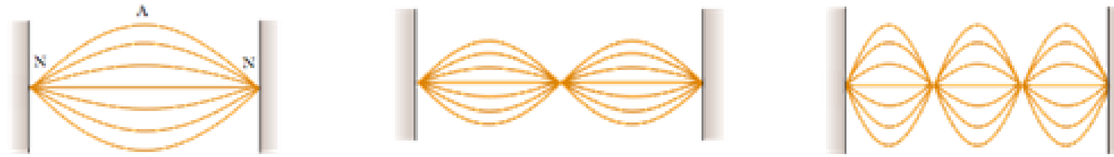
   b) Sketch the standing wave that results when the string is vibrated at twice this fundamental frequency.

   c) Determine the speed of the waves on the string when it is vibrated at this new frequency.

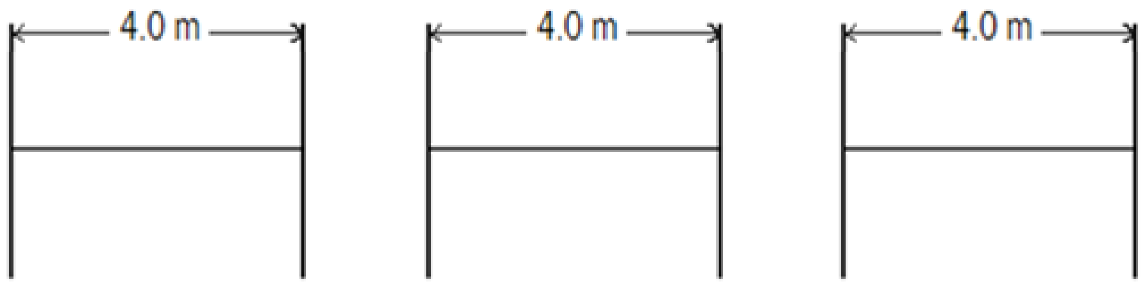
      Same string & same tension = v = 124 m/s



2. Standing waves are formed on a string that is 4.0 meters long. For the standing waves shown below, sketch them in the spaces provided and determine their characteristics. The speed of the component waves making up these standing waves is 12 m/s.



Name | Name | Name

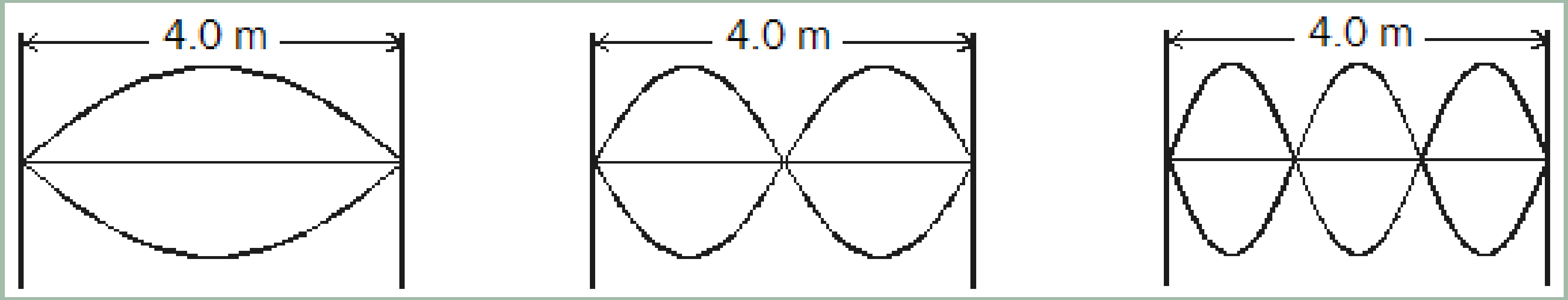


Wavelength	
Node(s)	
Antinode(s)	
Frequency	

Wavelength	
Node(s)	
Antinode(s)	
Frequency	

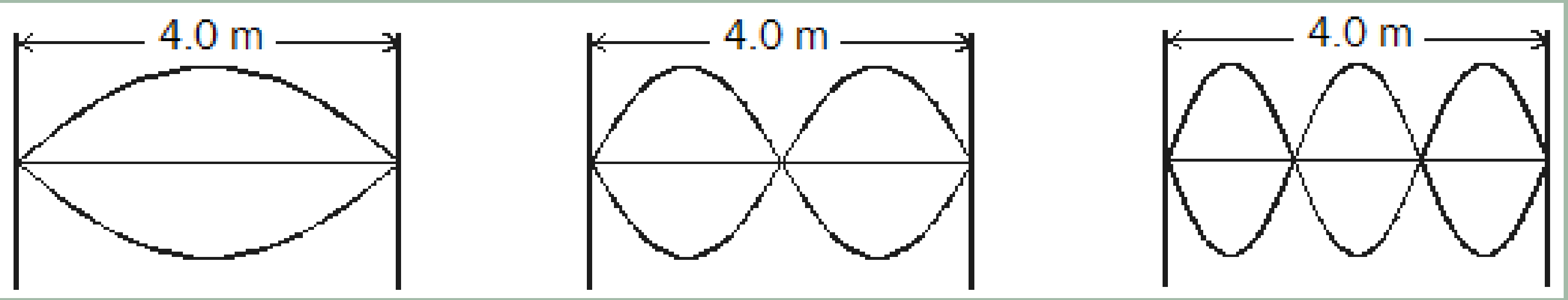
Wavelength	
Node(s)	
Antinode(s)	
Frequency	

Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



(First figure out how many waves are present)

Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



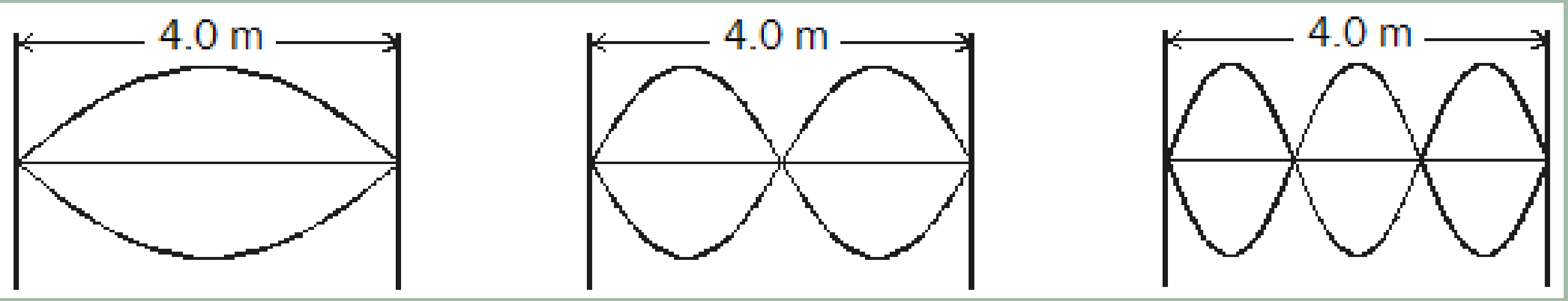
Half a wave

Whole wave

3/2 wave

(Then figure out wavelength.
The length of one wave.)

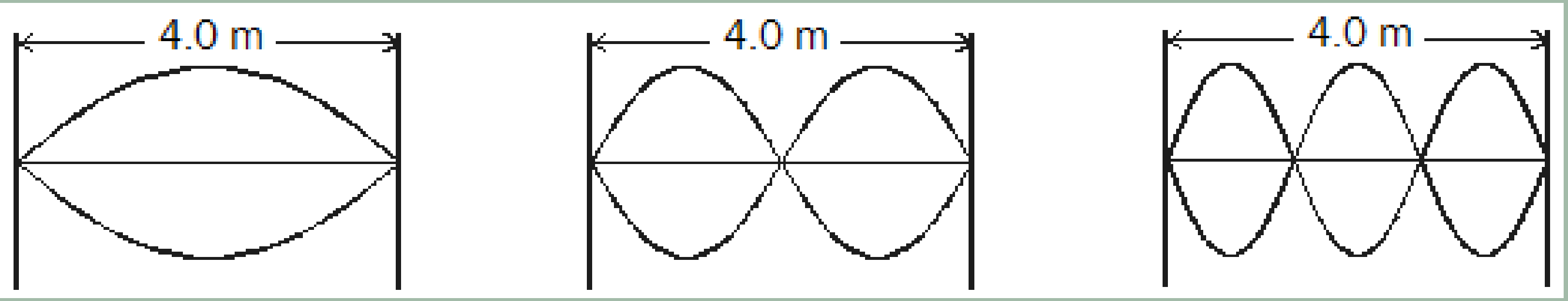
Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



8.0m 4.0 m 2.7 m

(Next, count the number of nodes. The outer edges count too.)

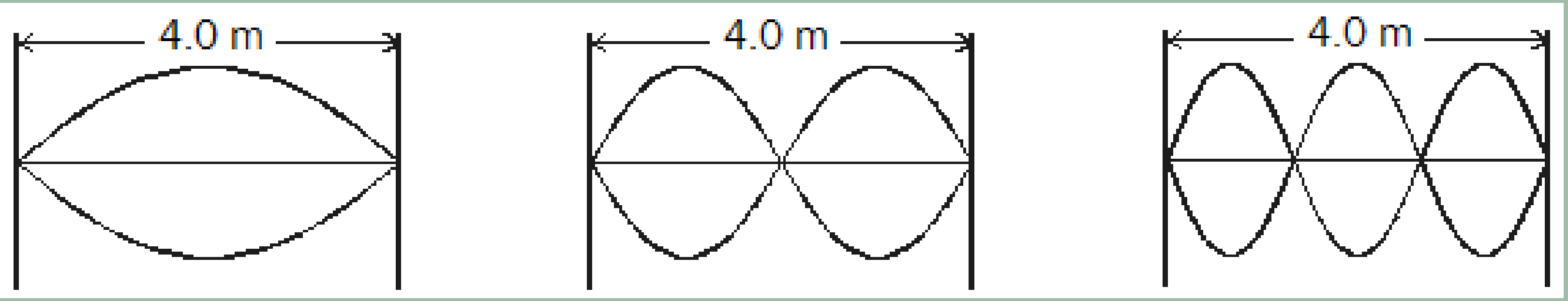
Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



2 3 4

(Next, count the number of antinodes. One crest/trough bubble counts as one antinode.)

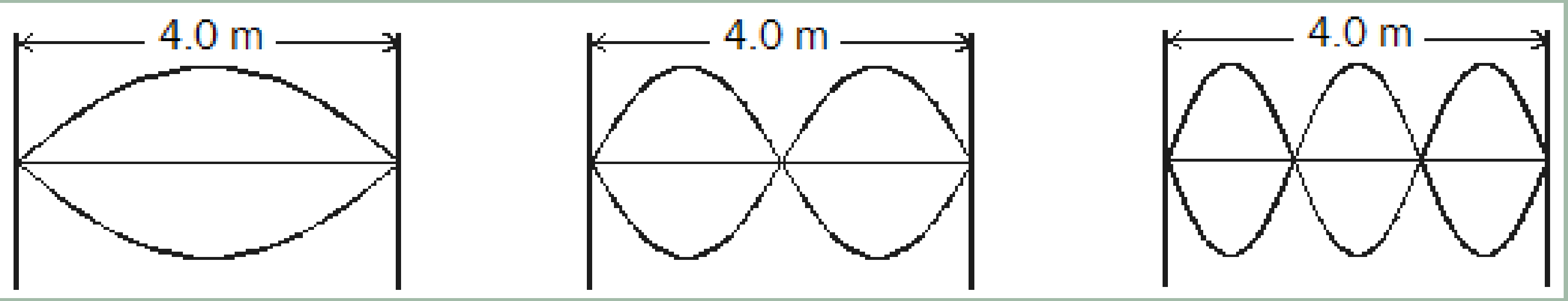
Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



1 2 3

(Finally, calculate the frequency using frequency = speed/wavelength.)

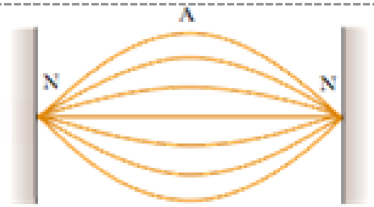
Determine the following for each diagram below: wavelength, number of nodes and antinodes, and frequency (for a given wave speed of 10.0 m/s).



1.5 Hz

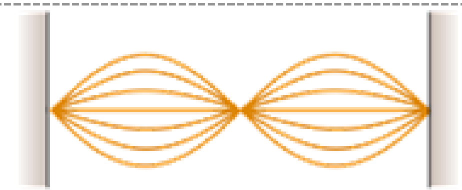
3.0 Hz

4.5 Hz



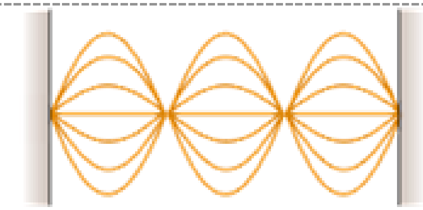
Name

1st Harmonic



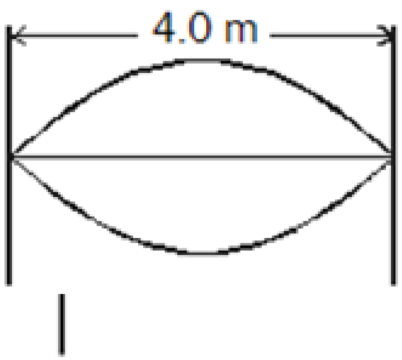
Name

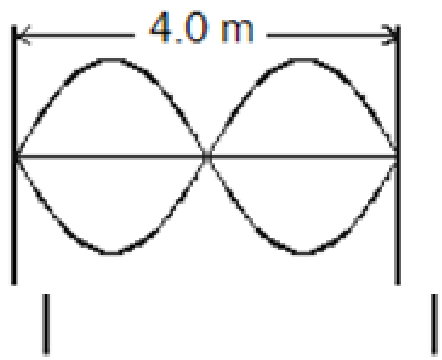
2nd Harmonic

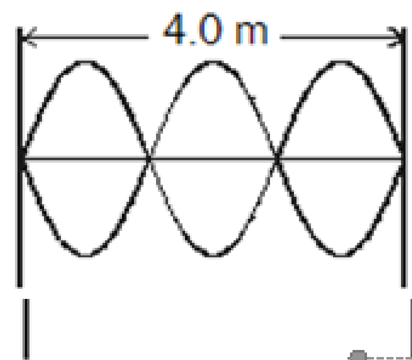


Name

3rd Harmonic







Wavelength	8.0 m
Node(s)	2
Antinode(s)	1
Frequency	1.5 Hz

Wavelength	4.0 m
Node(s)	3
Antinode(s)	2
Frequency	3.0 Hz

Wavelength	2.7 m
Node(s)	4
Antinode(s)	3
Frequency	4.5 Hz

$v = f \cdot \lambda$

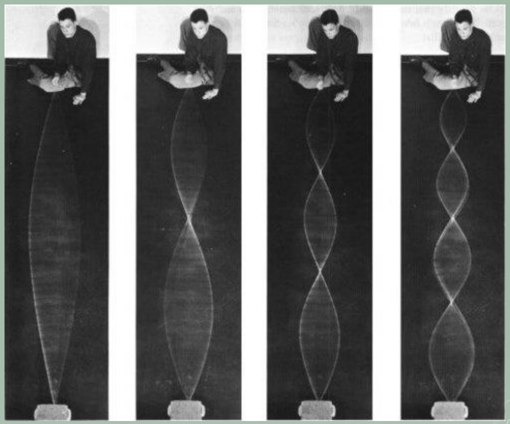
$f = v/\lambda$

$f = (12 m/s)/\lambda$

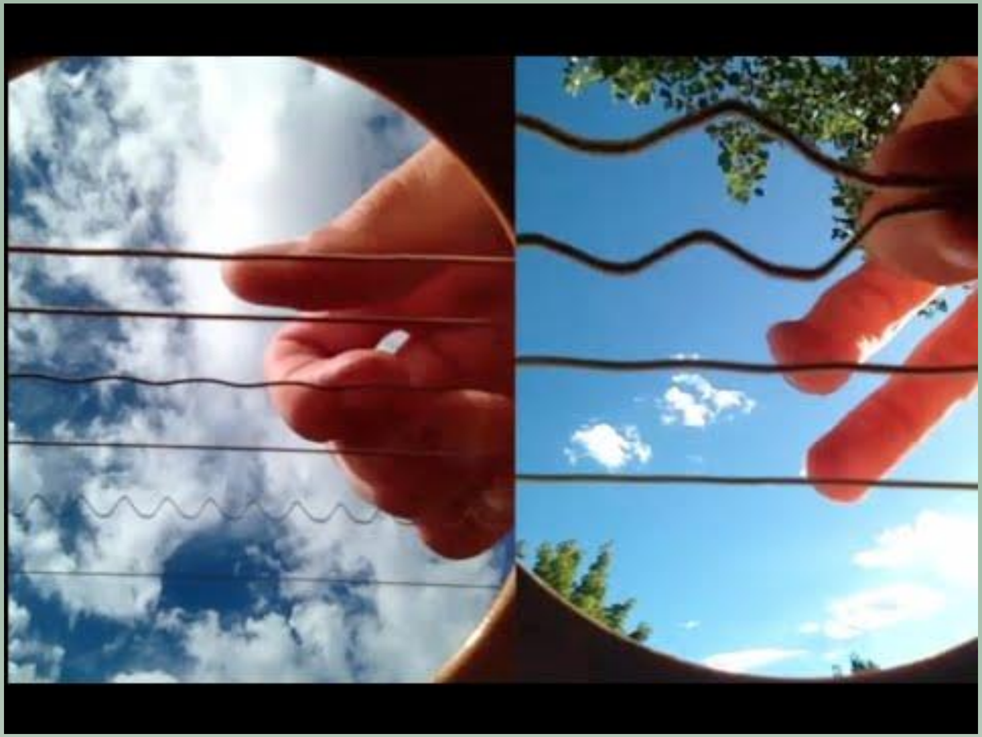
Standing Waves

How do the frequencies of the harmonic waves compare to the frequency of the fundamental wave?

integer multiples (quantized)



Standing Waves

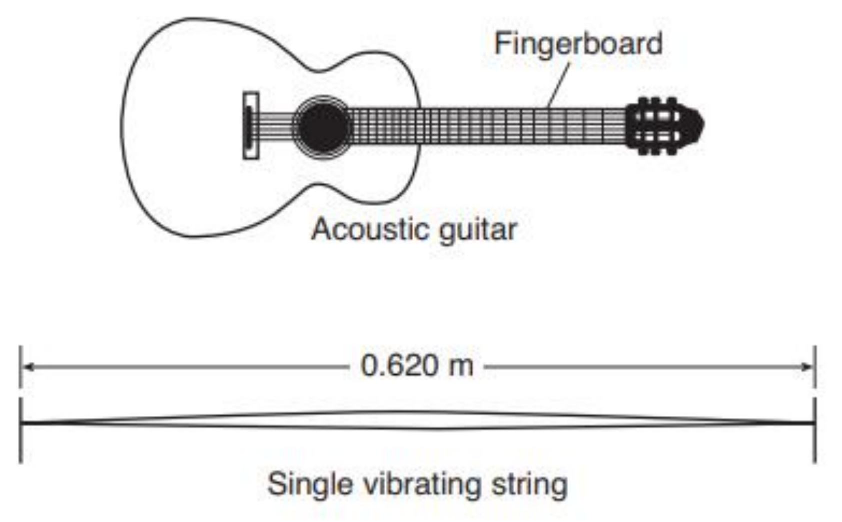


Watch the video.

https://www.youtube.com/watch?v=RNt8d6vJj8c

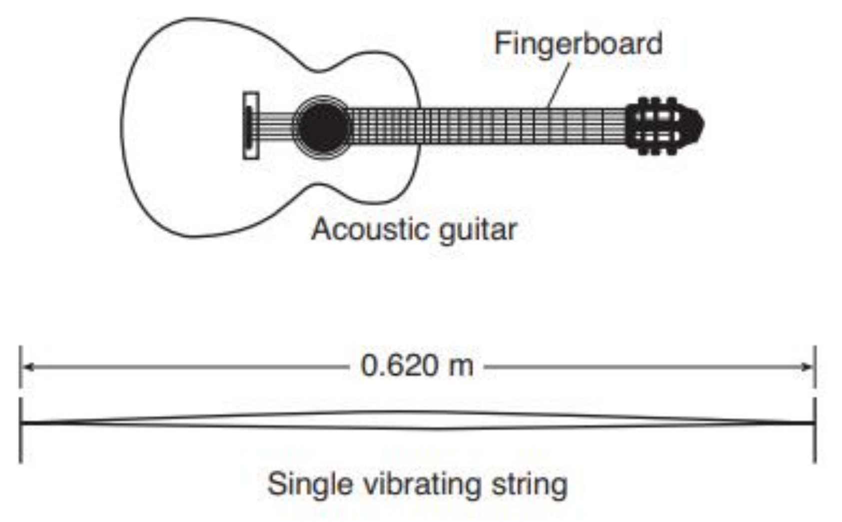
Standing Waves

A musician plucks a 0.620-meter-long string on an acoustic guitar, as represented in the diagram at right. Describe what happens to the frequency when the musician shortens the vibrating portion of the string by pinching the string against the fingerboard while the string continues to vibrate.



Standing Waves

A musician plucks a 0.620-meter-long string on an acoustic guitar, as represented in the diagram at right. Describe what happens to the frequency when the musician shortens the vibrating portion of the string by pinching the string against the fingerboard while the string continues to vibrate.



Since speed (v) remains constant, if the wavelength (λ) decrease, then frequency (f) will increase.