

Standing Waves

Let's assume that electromagnetic waves travel a way for trapped between two mirrors. There are standing waves.

A jump rope is a good example of a standing wave.



The jump is made negative going down to form a downward loop and then goes upward to the wave. Jump rope forms two other loops.

The places of zero-amplitude are called nodes. The places of greatest amplitude are called antinodes.



A standing wave

Standing waves are created by interference between two waves, so we show both the wave that is going to the right and the wave that is going to the left. It is made through it is formed going up and down, just like a jump rope.

In a standing wave, each antinode is one-half of a wavelength.

$$1 \text{ Antinode} = \frac{1}{2} \lambda$$

$$2 \text{ Antinodes} = \lambda$$

Two standing waves (the wave pattern) are shown below. Notice that wave length is measured to be equal to a distance by the time all the nodes passing through the wave.



Standing wave

A graph of the fundamental wave for the standing wave.

The longest wave that can be produced in a certain distance is called the fundamental. It is one-half of one wavelength long.

Standing Waves

Standing waves occur between objects whose distance is equal to the fundamental. Standing waves occur in the harmonics. Harmonics could be the jump that wave length, and then two, three, four, etc.

Part 1: Harmonics of a Vibrating String



Frequency of Harmonics

Frequency of the fundamental is $f_1 = \frac{v}{\lambda_1}$ and the wavelength is $\lambda_1 = 2L$.
 Frequency of the harmonics is $f_n = \frac{v}{\lambda_n}$.

(1) If the frequency of the first harmonic (fundamental) is f_1 , then the frequency of the harmonics is $f_n = n f_1$.

$$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$$

$$f_2 = \frac{v}{\lambda_2} = \frac{v}{L}$$

$$f_3 = \frac{v}{\lambda_3} = \frac{3v}{2L}$$

$$f_4 = \frac{v}{\lambda_4} = \frac{2v}{L}$$

$$f_5 = \frac{v}{\lambda_5} = \frac{5v}{2L}$$

(2) If the frequency of the first harmonic (fundamental) is f_1 , then the frequency of the harmonics is $f_n = n f_1$.

$$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$$

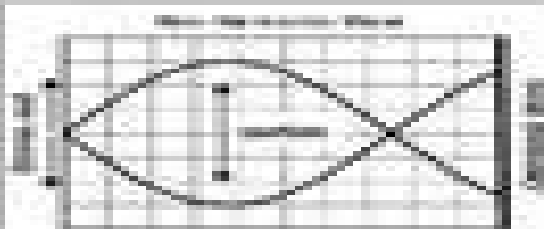
$$f_2 = \frac{v}{\lambda_2} = \frac{v}{L}$$

$$f_3 = \frac{v}{\lambda_3} = \frac{3v}{2L}$$

$$f_4 = \frac{v}{\lambda_4} = \frac{2v}{L}$$

$$f_5 = \frac{v}{\lambda_5} = \frac{5v}{2L}$$

The frequency of the wave can be found by the equation $f = \frac{v}{\lambda}$. The wave length is the distance between two consecutive nodes, and λ is the wavelength.



Examples of Standing Waves and their Harmonics				
1st Harmonic	2nd Harmonic	3rd Harmonic	4th Harmonic	5th Harmonic
$f_1 = \frac{v}{2L}$	$f_2 = \frac{v}{L}$	$f_3 = \frac{3v}{2L}$	$f_4 = \frac{2v}{L}$	$f_5 = \frac{5v}{2L}$

Standing Waves Unit 10 3 C Stephen Murray Answers

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