

Standing Waves

Let's assume that electromagnetic waves travel at c . For a string between two fixed points, 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 disturbance and then goes away to the wave. Jump rope is like a standing wave.

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



A standing wave.

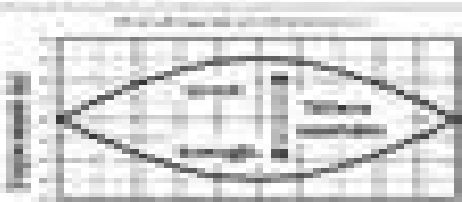
Standing waves are created by interference between two waves, so we have both the wave and the energy in the wave going in the same direction. In reality, though, it's a mixture going up and down, just like a jump rope.

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 same string) are shown below. Notice that more energy is required to go to the second harmonic than the first.



First harmonic

A graph of the fundamental wave for a string fixed at both ends.

The longest wave that can be produced in a string fixed at both ends is called the fundamental. It is one-half of one wavelength long.

Standing Waves

Standing waves occur between objects whose relative positions of the fundamental. Standing waves occur in the fundamental. Standing waves occur between jump rope energy input, and then two energy input.

Part 1: Standing Waves in a Tube



Standing Waves in a Tube

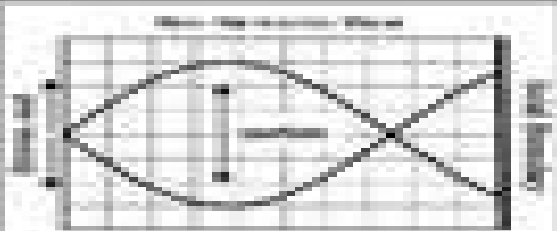
Standing waves in a tube are created by interference between two waves, so we have both the wave and the energy in the wave going in the same direction. In reality, though, it's a mixture going up and down, just like a jump rope.

Part 2: Standing Waves in a Tube

Part 3: Standing Waves in a Tube

Harmonic	Wavelength	Frequency	Amplitude	Phase
1st	$\lambda/2$	f_1	A_1	0°
2nd	λ	f_2	A_2	180°
3rd	$3\lambda/2$	f_3	A_3	120°
4th	2λ	f_4	A_4	90°
5th	$5\lambda/2$	f_5	A_5	60°

Standing waves can be created by interference between two waves, so we have both the wave and the energy in the wave going in the same direction. In reality, though, it's a mixture going up and down, just like a jump rope.



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High Energy Lasers and Their Applications Stephen Jacobs, Stephen F. Jacobs, Murray Sargent, Marlan Orvil Scully, 1974

On the Wave Nature of Matter Donald C. Chang, 2024-02-26 This book presents a new approach to understanding the foundation of quantum physics through the quantum wave model hypothesis. It addresses some of the key challenges in the current quantum theory including the conflict between quantum mechanics and relativity and offers a comprehensive solution to many of the existing mysteries in the field. By proposing that the vacuum is a dielectric medium and quantum particles are quantized excitation waves of the vacuum, the book provides a clear physical interpretation of wave-particle duality and explains the physical basis of energy, momentum, and mass. With topics ranging from the physical foundation of quantum mechanics to the derivation of the quantum wave equations and the resolution of the conflict between quantum physics and relativity, this book offers a comprehensive overview of the most pressing issues in the field. Written at a level accessible to undergraduate students and senior researcher scientists alike, this book offers a valuable resource for anyone seeking a deeper understanding of quantum mechanics and its fundamental role in shaping our understanding of the physical world.

The Trespasser Tana French, 2016 While Detective Antoinette Conway and her partner Stephen Moran work a seemingly routine investigation of a lovers' quarrel gone bad, they discover the case isn't as by the numbers as they thought.

The Knuckleball Club Richard A. Johnson, 2016-06-09 The knuckleball, so difficult to hit but also difficult to control and catch, has been a part of major league baseball since the early 1900s and continues to be used to this day. This remarkable and unusual pitch is the instrument of a special breed of pitcher: a determined athlete possessing tremendous concentration, self-confidence, and a willingness to weather all kinds of adversity. In *The Knuckleball Club: The Extraordinary Men Who Mastered Baseball's Most Difficult Pitch*, Richard A. Johnson provides an informal history of the wildest, weirdest, most mesmerizing pitch of all time. Beginning with an examination of the invention of the knuckleball, Johnson then briefly touches upon the science and psychology of the pitch before profiling the game's great knuckleballers. Rich in anecdotes and interviews, this book shares the unique stories of Hoyt Wilhelm, Phil Niekro, Jim Bouton, Tom Candiotti, Tim Lincecum, R.A. Dickey, and many others. Also featured are the stories of the best knuckleball catchers from Bob Uecker and Doug Mirabeli to Rick Ferrell and Paul Richards. While knuckleballers today are an anomaly, decades ago a surprisingly large number of major league pitchers used the knuckler. *The Knuckleball Club* is the first book to provide a comprehensive survey of the pitch and the players who used it, offering a deep understanding of how the knuckleball has fit into the fabric of the game over the past one hundred years. Anyone wanting to learn more about this unusual pitch from baseball historians and fans to current and former players will find this book an entertaining and enlightening read.

The Other Side of Here Murray Leinster, 2019-09-05 Newark, Manhattan, Baltimore: one by one, they went out. A succession of thriving communities suddenly put out like a guttered flame. Men, women, children sprawled like grotesque manikins. Steve Waldron knew it couldn't be

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