

Standing Waves

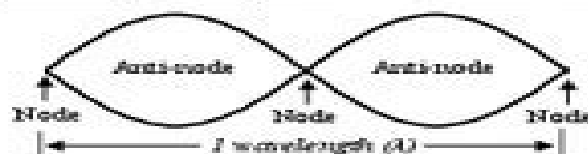
We know that waves move. Yet waves can be trapped between boundaries. These are known as *standing waves*.

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



To keep a standing wave going it needs to have a *driven end* and that gives energy to the wave. Jump ropes have *two driven ends*.

The places of no amplitude are called *nodes*. The places of greatest amplitude are called *anti-nodes*.



A moving wave.

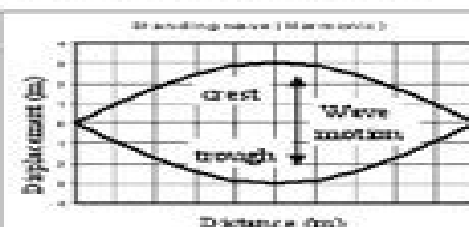
Standing waves are **TRAPPED** between boundaries, so we show both the crest and the trough in the same place at the same time. In reality, though, it alternates: going up and down, just like a jump rope.

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

$$1 \text{ Anti-node} = (1/2)\lambda$$

$$2 \text{ Anti-nodes} = \lambda$$

In a *moving wave*, the wave moves away from what drives it. Waves that move away from a rock in a pond are driven by the force of the rock pushing through the water.



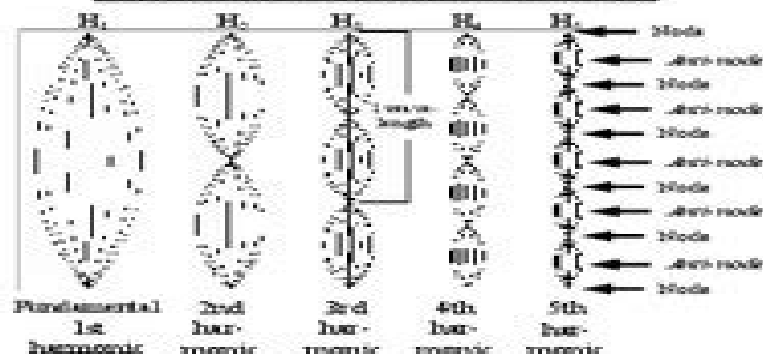
A graph of the fundamental wave for this distance.

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

Harmonics

Harmonics are waves that are whole number multiples of the fundamental. Harmonics sound louder, keep their energy longer, and take less energy to produce.

First 5 Harmonics of a Vibrating String



Frequency of Harmonics

$$\text{Frequency of harmonic } n \rightarrow f_{Hz} = f_1 (\infty) \leftarrow \begin{matrix} \uparrow \\ \text{Frequency of the} \\ \text{fundamental (in Hz)} \end{matrix} \leftarrow \begin{matrix} \leftarrow \\ \text{N of the} \\ \text{Harmonic} \end{matrix}$$

Ex. Find the frequency of the third harmonic (H_3) of a 4 Hz fundamental.

$$\begin{matrix} f_1 = 4 \text{ Hz} \\ n = 3 \\ f_{Hz} = ? \end{matrix}$$

$$\begin{matrix} f_{Hz} = f_1 (\infty) \\ f_{Hz} = (4 \text{ Hz}) \times (3) \\ f_{Hz} = \underline{12 \text{ Hz}} \end{matrix}$$

Ex. If the fifth harmonic has a frequency of 55 Hz, find the fundamental frequency.

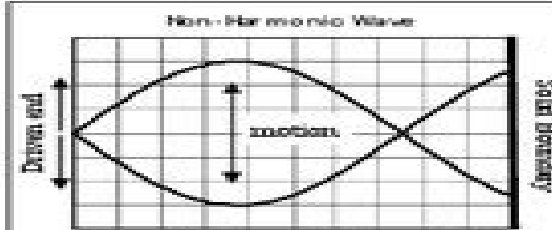
$$\begin{matrix} f_{Hz} = 55 \text{ Hz} \\ n = 5 \\ f_1 = ? \end{matrix}$$

$$\begin{matrix} f_{Hz} = f_1 (\infty) \\ f_1 = f_{Hz} / n = 55 \text{ Hz} / 5 \\ f_1 = \underline{11 \text{ Hz}} \end{matrix}$$

Examples of Fundamentals and their Harmonics

H_1 (f)	H_2	H_3	H_4	H_5
1 Hz	2 Hz	3 Hz	4 Hz	5 Hz
2 Hz	4 Hz	6 Hz	8 Hz	10 Hz
5 Hz	10 Hz	15 Hz	20 Hz	25 Hz
10 Hz	20 Hz	30 Hz	40 Hz	50 Hz

Non-harmonic waves can be forced into boundaries, too. The waves will die out quickly, sound quieter (if a sound wave), and take more energy to produce.



Standing Waves Worksheet 3 Key

Holt Rinehart & Winston

A red circular graphic with a gradient, appearing as a partial circle or a stylized wave, located to the right of the publisher's name.

Standing Waves Worksheet 3 Key:

Decoding **Standing Waves Worksheet 3 Key**: Revealing the Captivating Potential of Verbal Expression

In a time characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its capability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Standing Waves Worksheet 3 Key**," a mesmerizing literary creation penned by a celebrated wordsmith, readers attempt an enlightening odyssey, unraveling the intricate significance of language and its enduring impact on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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