Harmonics on Strings and in Pipes

We will use the Socratic Method to derive equations for harmonics on strings and in pipes. "Sit and learn, Aristotle."

Harmonics on Strings

- Fill in the equation at the right for how many antinodes (AN) equals 1 λ.
- 2) How many AN does the fundamental have?

 $-AN = \lambda$

- Above the diagram, write how many way elength. each harmonic is $(H_2$ is already done).
- 4) So, how many L's is the wavelength of the fundamental?
- 5) Under each harmonic, write its wavelength in terms of "L". (Hi is already done).
- You probably have the wavelength of the fundamental as a whole number, not a fraction. Make it a fraction, over 1.
- Notice the denominators of harmonics 1, 3, and 5. You should see a pattern. Change the fractions of the other harmonics (2 and 4) so that the pattern is the same for all of them.
- S) So, these changing denominators are the number of:
- Calling the denominator "n" (the number of antinodes). Now write a formula for finding the wavelength of a particular harmonic on a fixed string of length "L".



10) * On a 2.5 m string, what is the wavelength of the 8th harmonic?

$$\lambda_1 = 2.5 \ell = 5 = 5 = 5 = 625 m$$
 or $\lambda_8 = \frac{2\ell}{5} = \frac{2(3.5)}{6}$

11) If a mechanical vibrator is vibrating 460 times per second to produce the 8th harmonic you just found, find the speed of the wave in the string.

One other thing to notice: on a string it is possible to have every harmonic. There are no "missing harmonics".

Transfer of Waves Between Mediums

The speed of the wave is different in different mediums, so the speed of the wave is different in the string than in air.

- 12) The speed of sound in air varies between 330 Hz and 444 Hz. Let's use V_{sound} = 340 m/s.
- 13) If you tighten the string, will the wavelength of the harmonics change (is the string longer)? No.
- 14) * When I tighten a string on my guitar what does change (music-wise)? pitch or note.
- 15) When the string vibrates, it beats against the air, making the air molecules vibrate, too. Every time the string pushes, the air moves, too. So, what is the same in air as in a string: the wavelength of the vibration or the frequency of the vibration? WEEN
- 16) What frequency sound will we hear from the string in Q11?
- audible: 20 H2 -> 20,000 HZ 17) Is this audible to us (see "Sound" notes)? 9 05
- 18) What would be the wavelength of that sound in air? (You have speed and frequency...)

Notice in Q10: wavelength on string was 0.625m. and v = 287.5 m/s. f is same, but v is faster (340m/s), so wavelength increased: 0.739m.

Answer To Stephen Murray Magnetic Chapter 1

Rachel Sandford

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Peripheral and Spinal Mechanisms in the Neural Control of Movement M.D. Binder, 1999-12-17 In the last decade we have witnessed a striking maturation of our understanding of how neurons in the spinal cord control muscular activity and movement Paradoxically a host of new findings have revealed an unexpected versatility in the behavior of these well studied neural elements and circuits In this volume the world's leading experts review the current state of our knowledge of motor control outline their latest results and developments and delineate the seminal unresolved questions in this vibrant field of research The volume begins with a commentary and overview of our current understanding of the peripheral and spinal basis of motor control The remainder of the volume is divided into seven sections each focused on a different problem The first chapter in each section provides some historical review and presages the experimental findings and hypotheses that are discussed in subsequent chapters Topics include the biomechanics of neuromuscular systems the properties of motoneurons and the muscle units they control spinal interneurons pattern generating circuits locomotion descending control of spinal circuits comparative physiology of motor systems and motor systems neurophysiology studied in man The book serves as a unique reference volume and should be essential reading for anyone interested in motor systems Moreover the volume s comprehensive coverage of a wide range of topics make it an effective textbook for graduate level courses in motor control A New English Dictionary on Historical Principles: neurobiology kinesiology physical therapy and rehabilitation medicine part 1. A (1888) James Augustus Henry Murray, 1888 A New English Dictionary on Historical Principles: part 1. D Islands of Order J. Stephen Lansing, Murray P. Cox, 2019-10-08 Two (1897) James Augustus Henry Murray, 1897 pioneering anthropologists reveal how complexity science can help us better understand how societies change over time Over the past two decades anthropologist J Stephen Lansing and geneticist Murray Cox have explored dozens of villages on the islands of the Malay Archipelago combining ethnographic research with research into genetic and linguistic markers to shed light on how these societies change over time Islands of Order draws on their pioneering fieldwork to show how the science of complexity can be used to better understand unstable dynamics in culture language cooperation and the emergence of hierarchies Complexity science has opened exciting new vistas in physics and biology but poses challenges for social scientists What triggers fundamental discontinuous social change And what brings stable patterns islands of order into existence Lansing and Cox begin with an incisive and accessible introduction to models of change from simple random drift to coupled interactions phase transitions co phylogenies and adaptive landscapes Then they take readers on a series of journeys to the islands of the Indo Pacific to demonstrate how social scientists can harness these powerful tools to discover out of equilibrium social dynamics Lansing and Cox address empirical questions surrounding the colonization of the Pacific the relationship of language to culture the emergence and disappearance of male and female hierarchies and more Unlocking new possibilities for the social sciences Islands of Order is accompanied by an interactive companion website that enables

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