

Harmonics on Strings and in Pipes

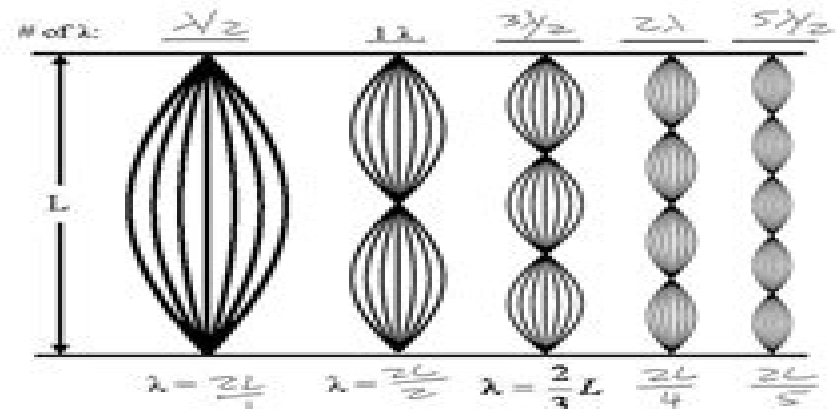
We will use the Socratic Method to derive equations for harmonics on strings and in pipes. "Sit and learn, Aristotle."

Harmonics on Strings

- 1) Fill in the equation at the right for how many antinodes (AN) equals 1 λ .
- 2) How many AN does the fundamental have?
- 3) Above the diagram, write how many wavelength each harmonic is (H_1 is already done).
- 4) So, how many L's is the wavelength of the fundamental?

$$\underline{2} \text{ AN} = \lambda$$

- 5) Under each harmonic, write its wavelength in terms of "L". (H_1 is already done).
- 6) You probably have the wavelength of the fundamental as a whole number, not a fraction. Make it a fraction, over 1.
- 7) 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.
- 8) So, these changing denominators are the number of:
- 9) 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?
 $\lambda_1 = 2.5(2) = 5\text{ m}$
 $\text{so } \lambda_8 = \frac{5}{8} = .625\text{ m}$ or $\lambda_8 = \frac{2L}{n} = \frac{2(2.5)}{8} = .625\text{ m}$
- 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.
 $v = f\lambda$
 $= 460(.625) = 287.5\text{ m/s}$

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 $v_{\text{sound}} = 340\text{ m/s}$.
- 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?
 $v = f\lambda$
- 16) What frequency sound will we hear from the string in Q11?
- 17) Is this audible to us (see "Sound" notes)? yes audible: 20 Hz $\rightarrow$ 20,000 Hz
- 18) What would be the wavelength of that sound in air? (You have speed and frequency...)

$$v = f\lambda$$

$$340 = 460\lambda \quad \lambda = .739\text{ m}$$

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

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Authoring Tools for Advanced Technology Learning Environments T. Murray, Stephen Blessing, S.

Ainsworth, 2003-12-31 This edited book gives a comprehensive picture of the state of the art in authoring systems and authoring tools for advanced technology instructional systems. It includes descriptions of fifteen systems and research projects from almost every significant effort in the field. The book will appeal to researchers, teachers, and advanced students working in education, instructional technology, and computer-based education, psychology, cognitive science, and computer science.

Civil War Flags of Tennessee Stephen Douglas Cox, 2024-01-12 Civil War Flags of Tennessee provides information on all known Confederate and Union flags of the state and showcases the Civil War flag collection of the Tennessee State Museum. This volume is organized into three parts. Part 1 includes interpretive essays by scholars such as Greg Biggs, Robert B. Bradley, Howard Michael Madaus, and Fonda Ghiardi Thomsen that address how flags were used in the Civil War, their general history, their makers, and preservation issues among other themes. Part 2 is a catalogue of Tennessee Confederate flags. Part 3 is a catalogue of Tennessee Union flags. The catalogues present a collection of some 200 identified extant Civil War flags and another 300 flags that are known through secondary and archival sources, all of which are exhaustively documented. Appendices follow the two catalogue sections and include detailed information on several Confederate and Union flags associated with the states of Mississippi, North Carolina, and Indiana that are also contained in the Tennessee State Museum collection. Complete with nearly 300 color illustrations and meticulous notes on textiles and preservation efforts, this volume is much more than an encyclopedic log of Tennessee-related Civil War flags. Stephen Cox and his team also weave the history behind the flags throughout the catalogues, including the stories of the women who stitched them, the regiments that bore them, and the soldiers and bearers who served under them and carried them. Civil War Flags of Tennessee is an eloquent hybrid between guidebook and chronicle, and the scholar, the Civil War enthusiast, and the general reader will all enjoy what can be found in its pages. Unprecedented in its variety and depth, Cox's work fills an important historiographical void within the greater context of the American Civil War. This text demonstrates the importance of Tennessee state heritage and the value of public history, reminding readers that each generation has the honor and responsibility of learning from and preserving the history that has shaped us all and, in doing so, honoring the lives of the soldiers and civilians who sacrificed and persevered.

Multiple Sclerosis Nancy Holland, T. Jock Murray, Stephen C. Reingold, 2007-02-15 The diagnosis of multiple sclerosis (MS) poses potential concerns related to all aspects of life and plans for the future. Family members and other loved ones are similarly concerned, and everyone involved struggles to make sense of life with this permanent intruder. One of the first responses is usually an active search for information about the disease itself and its potential long-term effects. Chapters discuss the nature of MS, its management, and guidelines for dealing with all aspects of the disease and its impact on your life. A chapter on services available from the National Multiple Sclerosis Society

a glossary a list of resources and additional reading suggestions make this the place to begin your education about MS With education and proper care most people diagnosed with multiple sclerosis will lead full and productive lives Multiple Sclerosis A Guide for the Newly Diagnosed Third Edition is an essential resource for everything you need to know about MS and includes new or updated sections on The most current medical treatments for the management of MS Complementary and alternative medicine and MS Financial and life planning Children with MS Updated diagnostic criteria *Visual Support for Children with Autism Spectrum Disorders* Vera Bernard-Opitz, Anne Häussler, 2011 Combining their years of experience working with individuals on the autism spectrum the authors bring practical ideas and teaching methods for offering visual supports to students with autism spectrum disorders [Catalog of Copyright Entries](#) Library of Congress. Copyright Office, 1977 *Books in Print Supplement*, 1988 [Cultural Property Acquisitions](#) Aimée L Taberner, 2016-06-16 Museum staff whether new to the field or working with collections for decades are often overwhelmed by the complexities of acquiring cultural property particularly antiquities and archaeological material Collecting practices now require a greater degree of transparency and cooperation with various stakeholders than in the past and are under greater scrutiny to be in line with current legal requirements and ethical expectations This book provides a concise unbiased and practical resource for those tasked with navigating the complicated and rapidly changing legal and ethical landscape governing the acquisition of cultural property and archaeological material **The Sustainable Self** Paul Murray, 2012-06-25 Achieving a sustainable society is the biggest issue of our time It is not an issue confined to a particular subject area or to certain jobs It is a way of thinking and behaving that will need to be embedded in all aspects of all of our lives The Sustainable Self is the perfect resource for lecturers trainers students and professionals of any discipline who need to teach or learn about sustainability There is widespread agreement that we need to live more sustainable lives But when up against entrenched habits and everyday obstacles it can be difficult to turn good intentions into action This book presents a complete curriculum for effecting a personal transformation towards sustainability showing you how to align your personal and professional actions with your values and beliefs Full of activities that can be done individually or in groups it is supported by additional resources online including downloadable worksheets and directories of sustainability organisations Recommended readings at the end of each chapter enable readers to pursue areas of personal or professional interest **Forthcoming Books** Rose Arny, 2003-12

Learning to Teach History in the Secondary School Terry Haydn, Alison Stephen, James Arthur, Martin Hunt, 2003-12-16 The revised edition of the highly successful first edition which has established itself as the student reference guide for student teachers of history **Resources in Education**, 1997-04 **Story Money Impact: Funding Media for Social Change** Tracey Friesen, 2016-02-12 Story Money Impact Funding Media for Social Change by Tracey Friesen is a practical guide for media makers funders and activists who share the common goal of creating an impact with their work Today social issues storytellers are sharpening their craft while funders with finite resources focus on reach and

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likely to present to a trainee in the emergency department Chapters are short and concise with key point boxes called Essentials at the beginning Also has boxes featuring controversial areas of treatment Practical and clinically orientated Major changes to resuscitation guidelines Complete rewriting of ENT section Significant updating of following topics acute coronary syndrome management trauma sepsis management imaging arrhythmias Expansion of administration section especially patient safety Changes to drug overdose sections in toxicology section Cultural Dilemmas of Progressive Politics Stephen M. Hart,2010-03-15 Why have conservatives fared so much better than progressives in recent decades even though polls show no significant move to the right in public opinion Cultural Dilemmas of Progressive Politics highlights one reason that progressives often adopt impoverished modes of discourse ceding the moral high ground to their conservative rivals Stephen Hart also shows that some progressive groups are pioneering more robust ways of talking about their issues and values providing examples other progressives could emulate Through case studies of grassroots movements particularly the economic justice work carried on by congregation based community organizing and the pursuit of human rights by local members of Amnesty International Hart shows how these groups develop distinctive ways of talking about politics and create characteristic stories ceremonies and practices According to Hart the way people engage in politics matters just as much as the content of their ideas when activists make the moral basis for their activism clear engage issues with passion and articulate a unified social vision they challenge the recent ascendancy of conservative discourse On the basis of these case studies Hart addresses currently debated topics such as individualism in America and whether strains of political thought strongly informed by religion and moral values are compatible with tolerance and liberty **Introduction to Finance** Ronald W. Melicher,Edgar A. Norton,2019-10-08 Introduction to Finance 17th Edition offers students a balanced introduction to the three major areas of finance institutions and markets investments and financial management Updated to incorporate recent economic and financial events this new edition is an ideal textbook for first courses in finance reviewing the discipline s essential concepts principles and practices in a clear reader friendly manner Students gain an integrated perspective of finance by learning how markets and institutions influence and are influenced by individuals businesses and governments Designed to impart financial literacy to readers with no previous background in the subject the text provides a solid foundation for students to build upon in later courses in financial management investments or financial markets Equations and mathematical concepts are kept to a minimum and include understandable step by step solutions Divided into three parts the book explains financial markets discusses the functions of financial systems reviews savings and investments in different sectors describes accounting concepts and organizational structures and more Real world examples featured throughout the text help students understand important concepts and appreciate the role of finance in various local national and global settings British Education Index ,2004

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