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.

Ancillary Sound Topics Answer

Theo Koupelis, Karl F. Kuhn

Ancillary Sound Topics Answer:

Sound and Light William Duckworth, Richard Fleming, 2009 This book is a collection of essays and original material that introduces the avant garde artist collaborators La Monte Young and Marian Zazeela to those unfamiliar with their life and art as well as providing the more acquainted readers with new and useful insights and analyses of the fundamental issues in their life and work The book explores the recurring themes that have influenced Young's minimalist music and Zazeela's ongoing engagement with the use of light in art These themes include the importance of nature and its natural shapes and sounds the importance of mathematics and organized tuning systems based on natural harmonics enhanced attention spans and increased sensitivity to differences within apparent sameness extensions of time and alterations of space Essays by Terry Riley John Schaefer Henry Flynt Christine Christer Hennix Mitchell Clark Kyle Gann Ben Neill and Robert Palmer are included Young and Zazeela contribute to the book with original text materials that focus on continuous sound and light environments Remedies Richard L. Hasen, 2010-01-01 Examples builds student understanding step by step moving from the basics to the more complex and allowing students to apply the law to particular fact patterns allows students to study chapters in any order demystifies the language of remedies using straightforward and student friendly examples charts and illustrations shows students how to do the math related to issues such as computing compensatory damages present value and constructive trusts offers compatibility with all major remedies books including those that approach remedies through public law and those that approach it through private law remains the only book in the field to provide both black letter law and examples and answers to build student knowledge the level of complexity builds as examples continue in each chapter discusses major remedies cases Hadley v Baxendale State Farm v Campbell Sullivan v O Connor provides detailed coverage of the draft Restatement Third of Restitution and gives detailed analyses of remedies issues under Article 2 of the Uniform Commercial Code Selected Topics in the History of Biochemistry. Personal Recollections. IV G. Semenza, E.C. Slater, R. Jaenicke, 2012-12-02 The editors invited selected authors who had participated in or observed developments in biochemistry and molecular biology particularly in the second half of this century to record their personal recollections of the times and circumstances in which they worked Having been given free reign both content and style of the contruibutions reflect the flavour of the personality of the author The book reflects the explosive development of biochemistry and molecular biology and related sciences that had led to the almost unique situation of these fields coming of age at a time when their founding fathers or their scientific children were alive and well The contributions in this volume encompass a wide variety of experiences in many different countries and in very different fields of biochemistry Resources for Teaching Middle School <u>Science</u> Smithsonian Institution, National Academy of Engineering, National Science Resources Center of the National Academy of Sciences, Institute of Medicine, 1998-04-30 With age appropriate inquiry centered curriculum materials and sound teaching practices middle school science can capture the interest and energy of adolescent students and expand their

understanding of the world around them Resources for Teaching Middle School Science developed by the National Science Resources Center NSRC is a valuable tool for identifying and selecting effective science curriculum materials that will engage students in grades 6 through 8 The volume describes more than 400 curriculum titles that are aligned with the National Science Education Standards This completely new guide follows on the success of Resources for Teaching Elementary School Science the first in the NSRC series of annotated guides to hands on inquiry centered curriculum materials and other resources for science teachers The curriculum materials in the new guide are grouped in five chapters by scientific area Physical Science Life Science Environmental Science Earth and Space Science and Multidisciplinary and Applied Science They are also grouped by type core materials supplementary units and science activity books Each annotation of curriculum material includes a recommended grade level a description of the activities involved and of what students can be expected to learn a list of accompanying materials a reading level and ordering information The curriculum materials included in this book were selected by panels of teachers and scientists using evaluation criteria developed for the guide The criteria reflect and incorporate goals and principles of the National Science Education Standards The annotations designate the specific content standards on which these curriculum pieces focus In addition to the curriculum chapters the guide contains six chapters of diverse resources that are directly relevant to middle school science Among these is a chapter on educational software and multimedia programs chapters on books about science and teaching directories and guides to science trade books and periodicals for teachers and students Another section features institutional resources One chapter lists about 600 science centers museums and zoos where teachers can take middle school students for interactive science experiences Another chapter describes nearly 140 professional associations and U S government agencies that offer resources and assistance Authoritative extensive and thoroughly indexed and the only guide of its kind Resources for Teaching Middle School Science will be the most used book on the shelf for science teachers school administrators teacher trainers science curriculum specialists advocates of hands on science teaching and concerned parents Remembrancer .1823 Refactoring SQL Applications Stephane Faroult, Pascal L'Hermite, 2008-08-22 What can you do when database performance doesn't meet expectations Before you turn to expensive hardware upgrades to solve the problem reach for this book Refactoring SQL Applications provides a set of tested options for making code modifications to dramatically improve the way your database applications function Backed by real world examples you ll find quick fixes for simple problems in depth answers for more complex situations and complete solutions for applications with extensive problems Learn to Determine if and where you can expect performance gains Apply quick fixes such as limiting calls to the database in stored functions and procedures Refactor tasks such as replacing application code by a stored procedure or replacing iterative procedural statements with sweeping SQL statements Refactor flow by increasing parallelism and switching business inducted processing from synchronous to asynchronous Refactor design using schema extensions regular

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