Did you complete at least 50% of Chapter 18.8?

A. Yes
B. No

Strings and pitches: the 12 tone scale

Tubes and pitch: octaves, 5th, 4th, & 3rd

Why does a trumpet sound different from a violin?- the importance of Overtones/Harmonics

Fourier: adding up overtones & the heat of planets.

Sitting in front: Rest of H, I and Je.
Dear students:
Making it official:
Lab 3: based on the fact that it was not set up in time. It will now be due 6 Feb. However there may be an exam question on it so go over it before the exam if you can.
Exam 1 will start 2:00 Friday and ends 2:00 Tuesday.
for day 10 Wednesday 28 January 2009:
   bring your chapter summaries and
   Reading is 18.8
HW 9 has a turn in portion.
DDA
9-6. A wave traveling to the right has the form \( y = y_0 \sin(kx - \omega t) \) and another wave traveling to the left has the form \( y = y_0 \sin(kx + \omega t) \). The two waves are superimposed.

(a) Using trigonometric identities, show that together they form a standing wave which can be written as \( y = 2y_0 \sin(kx) \cos(\omega t) \).

(b) Make a sketch of the standing wave for several arbitrary times superimposed on one another. Take the amplitude \( y_0 \) to be 10 cm and the wavelength to be 1 m.

Turn in this problem on paper using the 10 lower bins near our classroom. Use the bin that corresponds to the first digit of your class ID number.
IN THESE 10
Music and harmonics

class 10
600 BC was a rocking time

• Pythagoras.
  – All is numbers
  – Music as demonstration of this.
  – Halving and 1/3-ing the string. Etc.

• Music tones are caused by exciting standing waves.

• Violin A string now defined as 440 Hz
Consider the wave form from an instrument.
Violiin has one loop two loops three four etc. all at the same time

Octaves
440
880
1320
1760
220

"Well-tempered" Keyboard
12 equal intervals in octave

\[ 2^{\frac{1}{12}} = 1.05946 \]
Concert A

1  440 Hz  A
2  880    A\text{\# octave}
3  1320   A\text{\# fifth}
4  1760   E\text{\# fourth}
5  2200   A\text{\# major third}
6  2640   C\#\text{\# minor third}
7  3080   E\text{G-G}\text{\#}
8  3520   A
Please go to the computer resources on line: http://stokes.byu.edu/computer_resources.html

Find addwave and run it.
Demo violin

• Touch midpoint
• 1/3 of way from bridge etc.
• What about 2/3 of way?
• What about if place finger lightly?
2. If you touch a violin string at a place on the neck, how does the tone change? pp.

A. the pitch goes down
B. the pitch goes up
3. Consider the A string on a violin (440 Hz). What frequency (pitch) do we hear if we touch the string at a point \( \frac{2}{3} \) the length of the string? pp

A. 440 Hz
B. 267 Hz
C. 660 Hz
D. 880 Hz
E. 1320 Hz
A violin and a trumpet can both play an A. but they sound different. How come?
Let’s go to the computer resources on line: http://stokes.byu.edu/123-resources.html

Find Violin and run it.
Consider the wave form of violin Pendulum Court?
Figure 18.19

(a) Tuning fork

(b) Flute

(c) Clarinet
Frequency ►►

(a) Harmonics

(b) Harmonics

(c) Harmonics

Tuning fork

Relative intensity

1 2 3 4 5 6

1 2 3 4 5 6 7

1 2 3 4 5 6 7 8 9

CCGCEG

CCGCEG

CCGCEG

Flute

Clarinet

Serway, Physics for Scientists and Engineers, 5/e
Figure 18.20

Harcourt, Inc.
Fourier Analysis

Square wave

\[ f + 3f + 5f + 7f + 9f + \ldots \]
Organ Pipes: \( \text{pitch} = \frac{v}{2L} \)

- Middle C = 262 Hz
- 2 octaves down is \( f = \frac{262}{2^2} = 65 \text{ Hz} \)
- \( L = \frac{1}{2} \frac{343 \text{ m/s}}{65 \text{ s}} = 2.6 \text{ m} \approx 8 \text{ ft} \)
- 3 octave above C Pipe is \( \frac{8}{2^5} = 3 \text{ in.} \)
5 Octaves = 61 Keys

= 61 pipes = "rank" of pipes

8' rank

3 in.

4' rank

1 1/2 in.
\[
\frac{1}{2} \lambda \\
\frac{1}{4} \lambda
\]

\[
L = 16 \text{ ft} \\
\lambda = 32 \text{ ft}
\]

\[
L = 8 \text{ ft} \\
\lambda = 32 \text{ ft}
\]
How hot should the earth be?

• 1366.1 W/m². This is the solar constant.

• Fourier is credited with the discovery in 1824 that gases in the atmosphere might increase the surface temperature of the Earth [1]. This was the effect that would later be called the greenhouse effect. He established the concept of planetary energy balance - that planets obtain energy from a number of sources that cause temperature increase. Planets also lose energy by infrared radiation (that Fourier called "chaleur obscure" or "dark heat") with the rate increasing with temperature. A balance is reached between heat gain and heat loss; the atmosphere shifts the balance toward the higher temperatures by slowing the heat loss.

AIP: http://www.aip.org/history/climate/co2.htm
How planets stay warm.

• The earth is about 30 °C warmer than it would be without an atmosphere.