MUSIC HW: ***ANSWERS***

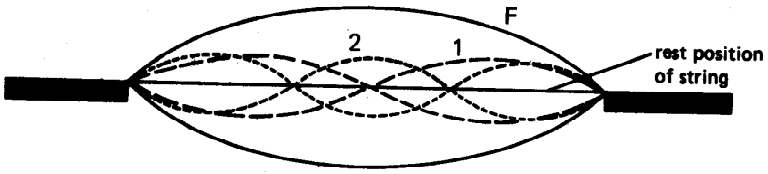
l. A group of tones that have regular wave patterns is:
MUSIC
2. Sounds with an irregular wave pattern are called: ***NOISE***
3. Identify three properties of musical tones that can be distinguished by the human ear.
a. the frequency of the sound wave: ***PITCH (Hz)***
the amplitude of the sound wave: ***LOUDNESS (DECIBEL)***
the tone's distinct sound: ***(QUALITY)***

1. State what is meant by the fundamental frequency and overtone of a musical tone:
Fundamental: Main note, usually the lowest, corresponding to the longest resonant wavelength. Overtones: harmonics, or other notes made by the object vibrating a different way. Usually a whole number multiple of the fundamental.
5. Identify the four classes of musical instruments and give at least one example of each.
is called
a. ***STRING: (node<->node) guitar, violin, piano***
b. ***CLOSED PIPE (node<->antinode), reed instruments: sax, clarinet, oboe, etc…***
c. ***OPEN PIPE (antinode<->antinode) brass? Flute, tuba, trumpet, etc..***
d. ***2dimensional (PERCUSSION)---- drum, etc…***

6. Explain the function of a vibrator and a resonator in musical instrument.
The thing that vibrates is the driving force…. the reed, you mouth, the pick, the hammer, etc…. if it does it correctly it will cause the object to resonate at its natural frequency…. The air in a tube or pipe, or the string, or the drum head, etc..
7. The pitch of one string on your guitar is too low. What will you do to correct it? Why
You could shorten the string (shorter wavelength=higher frequency) OR make it thinner or tighter (faster speed, same wavelength = higher frequency)

FUNDAMENTALS

A vibrating string produces sound waves with the lowest frequency, the fundamental frequency. Vibrating in parts, the string produces higher frequencies, called overtones, that are multiples of the fundamental frequency.

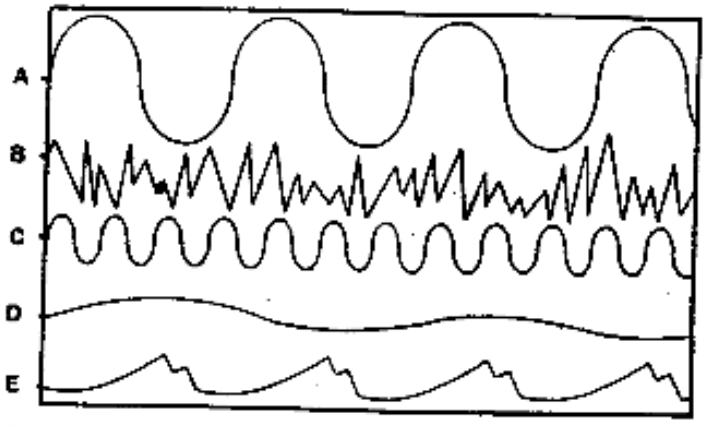


The diagram above shows a vibrating string on an imaginary string instrument. Use it to answer the following.

1. **Put an "F" next to the line that represents the fundamental frequency.**
2. **Put a "1" next to the line that is the first overtone.**
3. **Put a "2" next to the line that shows the second overtone.**

F is the lowest note... the long wavelength, 1 is the first overtone (f1=2f0), 2 is the 2nd overtone (f2=3 f0)

The source of any sound wave is vibration of matter. These vibrations may vary in size and frequency. A short, high-frequency vibration produces a high-pitched sound. A large amplitude in a wave indicates a loud sound. Study the diagram of sound waves below and answer the following questions.



See other side too!

1. Which vibration represents the following sounds?

a. A A very loud sound

b. E Music

c. C The highest pitch

d. B Noise

e. D A very soft sound

2. When a person is playing a wind instrument, such as a flute, what is vibrating to produce the sound?

The air is vibrating (open pipe)

3. You can use an empty bottle to produce a musical tone by gently blowing across the opening. If you add water to the bottle, how will it affect the sound? Explain.

adding water would decrease the air, thus decreasing the wavelength, thus a higher pitch (closed pipe)

4. Describe the way in which string instruments produce sound.

The string vibrates up and down, back and forth, etc.. node to node with several different modes of vibration; a fundamental and harmonics... then the wood/air resonates with the string.

5. Describe two ways to raise the pitch of the sound made by a vibrating string.

shorten the string (shorter WL, higher f) or tighten it (faster v, higher f)

PROBLEMS: (Sec 13-3,13-4)

1) On a piano, the note middle C has a fundamental frequency of 264 Hz. What is the second harmonic (1st overtone) of this note?
Piano=string….. 1st overtone is 2 * f0 = 528 Hz…
WL0= 2/1 L , WL1= 2/2 L so f1 = 2*f0
2) If the piano wire in item one is 66 cm long, what is the wavelength of the sound? What is the speed of sound?
WL0 for the fundamental is 2*.66 cm = 1.32 meters. For the first overtone WL1=.66m
V= WL*f = 1.32 * 264 = 348.48 m/second

3) A piano tuner using a 392 Hz tuning fork to tune the wire for G natural hears four beats per second. What are the two possible frequencies of vibration of this piano wire?
The piano wire could be at 396 Hz or at 388 Hz.

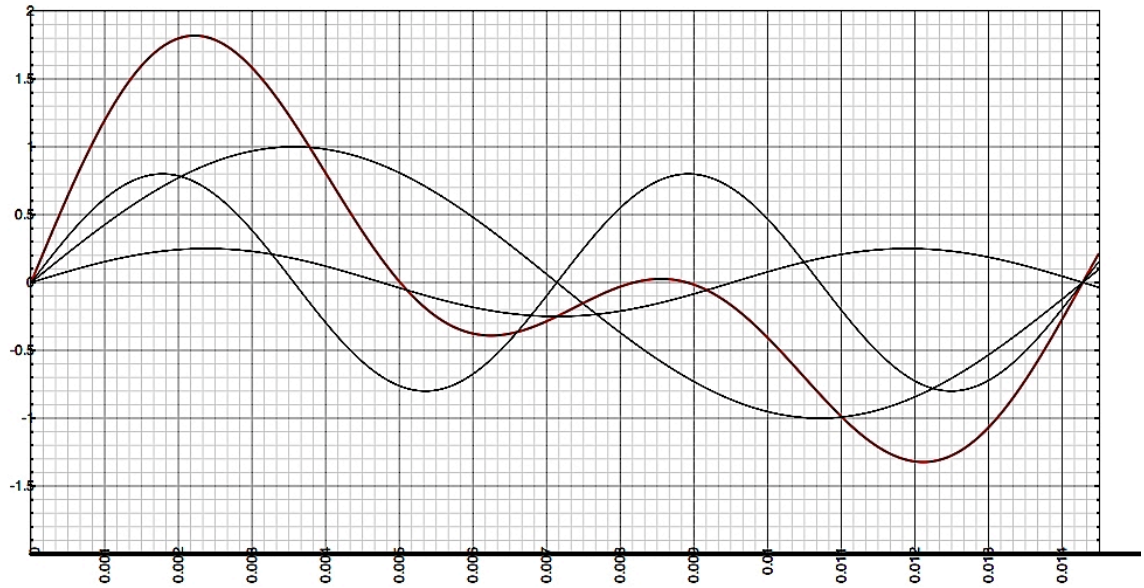
4) In a clarinet, the reed end acts as a closed, and the first hole acts as an open. What is the wavelength of the fundamental and the first two overtones as compared to the length of the pipe? What are the frequencies?
WL0 = 4 L , WL1 = 4/3 L , WL2 = 4/5 L
f0= V/ WL0 , f1 =3 f0 , f2 = 5 f0 etc…

5) A .2 m long organ pipe is closed at one end. What is its fundamental frequency when the temperature of the air is 35 degrees Celsius? What are the frequencies of the first two overtones?
WL0 = 4 L = 4 * .2 = .8 meters. The v of sound = 331 + .6 * °C = 331 +.6*35=352 m/s
F0 = V/WL0 = 352/.8 = 440 Hz (concert A).
F1 = 3F0 (for a closed pipe) = 1320 Hz, F2 = 5F0=2200 Hz

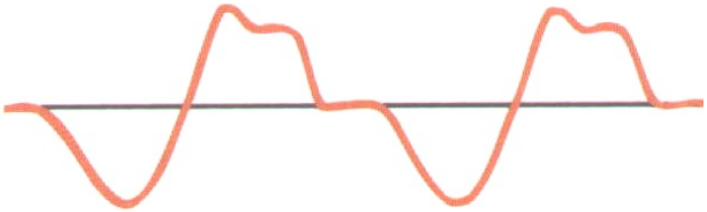
6) Mr T is singing an A note at 440 Hz. His voice isn't so pure, and he has an strong overtone at 880 Hz and a weak (1/4 amplitude of the fundamental) at 660 Hz.

Draw each wave. (Hint use graphing calculator?!)
Y1= 1* sin (440x), Y2 = .8* sin (880x), Y3= .25 * sin (660x)

Draw what the superposition of the waves would look like:
Y= 1* sin (440x) + .8* sin (880x) + .25 * sin (660x)



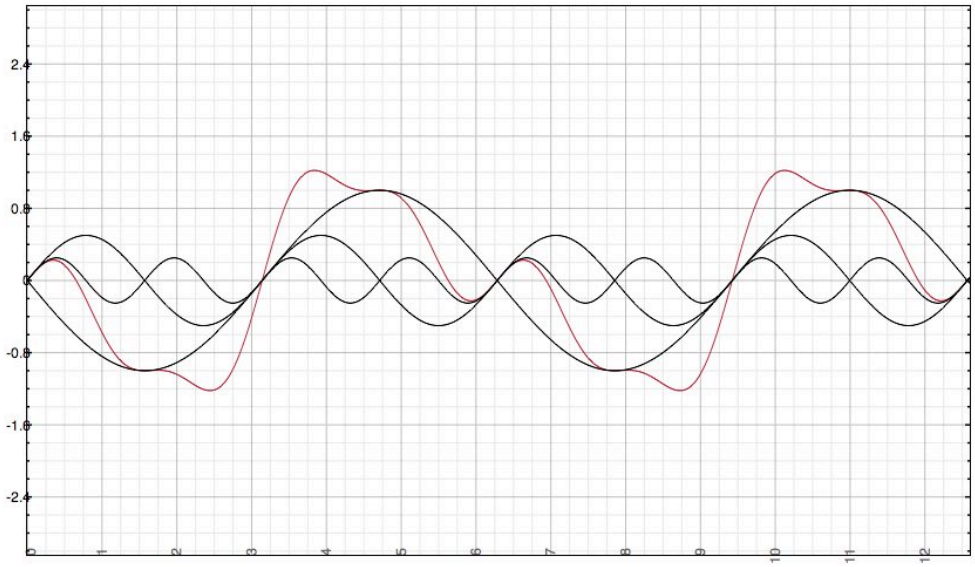
*** Honors:
Find the fundamental and overtones that would match this: (Fourier analysis)

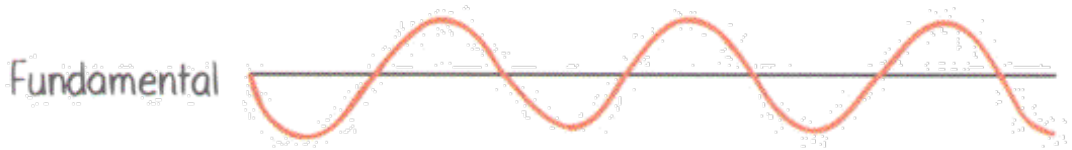


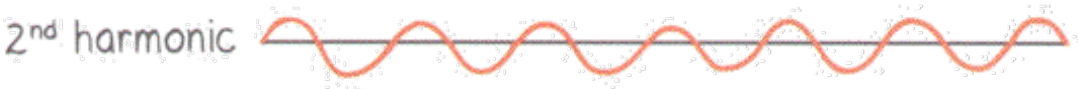
You should be able to tell that there are 3 waves added together, and you see two complete patterns.
The lowest frequency (longest wavelength) is the strongest, and the other shorter ones are a bit weaker. But one of them is 180degrees out of phase! -sin

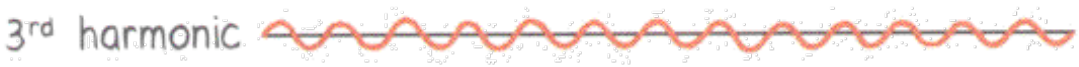
So maybe:

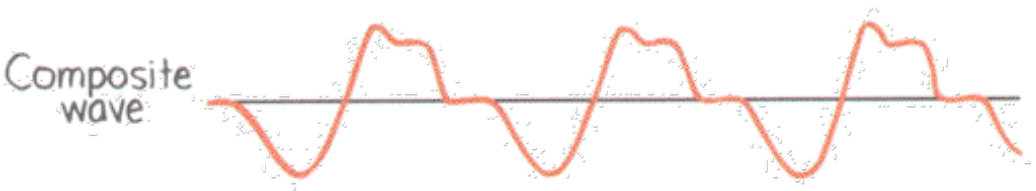
$$-1 * \sin X + \tfrac{1}{2} * \sin 2x + \tfrac{1}{4} * \sin 4x$$


2.4
1.6
0.8
0
-0.8
-1.6
-2.4
0
1
2
3
4
5
6
7
8
9
10
11
12


Fundamental


2nd harmonic


3rd harmonic


Composite
wave