Name:________________________

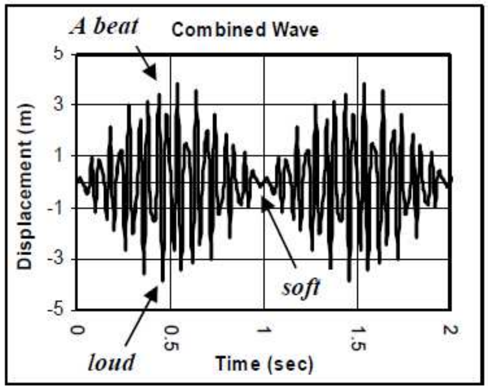
Ancillary Sound Topics

Beats

When two notes of sound are very close together we hear them fight with an alternating loud and soft pattern, called **beats** (sounds like a fast "wah, wah, wah").

Beats come from interference. When two waves of close frequencies interact they interfere, causing alternating constructive and destructive interference. The constructive interference is the loud part and the destructive, the soft part of the pattern. The closer the frequencies of the two notes, the slower the beats.

On the graph there is one beat per second.
Frequency 1 = 680 Hz
Frequency 2 = 681 Hz OR 679 Hz.



# of beats = difference between two frequencies.

Ex 1: f_1 = 345 Hz; f_2 = 342 Hz
beats = 3
There will be three beats per second.

Ex 2: f_1 = 805 Hz; f_2 = 810 Hz
beats = 5

Doppler Effect

When a train or ambulance passes you, the pitch drops. This change of pitch is due to the relative movement between the sound source and the observer and is called the **Doppler effect**.

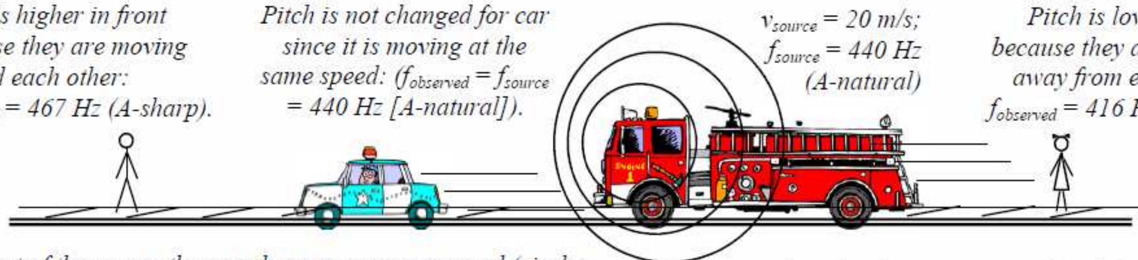
The Doppler Effect occurs only when a sound source and observer (the listener) are moving toward or away from each other. Since the speed of sound is a constant in a particular medium, the wavelength and frequency change instead. The pitch only changes as the sound passes you. As the sound approaches, the amplitude (volume) increases, but the pitch stays constant (unless the sound source is accelerating, of course). **Since the Doppler Effect is about relative motion, it doesn't actually matter who is moving. <u>The effect is be the same if the sound is stationary and the observer (listener) is moving.</u>**

Pitch is higher in front because they are moving toward each other: $f_{observed}$ = 467 Hz (A-sharp).

Pitch is not changed for car since it is moving at the same speed: ($f_{observed} = f_{source}$ = 440 Hz [A-natural]).

v_{source} = 20 m/s; f_{source} = 440 Hz (A-natural)

Pitch is lower behind because they are moving away from each other: $f_{observed}$ = 416 Hz (A-flat).



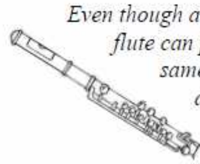
In front of the source the sound waves are compressed (circles are closer together), causing a shorter λ and a higher frequency. Behind the source the sound waves are stretched (circles are farther apart), causing a longer λ and a lower frequency.

When the siren passes you the pitch drops because you are changing from a position of compressed waves to stretched waves.

Timbre

A flute and a clarinet can play the same note (frequency) but they sound very different. This quantity of sound coloration is called **timbre** (*pronounced "tamber"*).

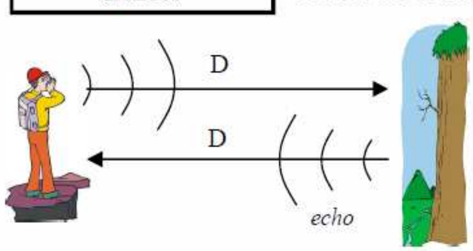
A person can sing the vowels "oo" and "ee" on the same notes. The "oo" sounds very dark, while the "ee" sounds very bright. The frequency of the note is that of the fundamental. The color of the note (bright, dark, dull, warm) is due to harmonics. The "oo" has mostly low harmonics, while the "ee" has a lot of high harmonics.



Even though a guitar and flute can play some of the same notes, you can easily distinguish them by their color or timbre.

Echoes

Echoes are sounds that are reflected back by a hard boundary.



An echo travels a distance of 2D: there and back!.

For echo problems:

$$V = \frac{2D}{T}$$

Many animals use ***echolocation*** to see through dark water or at night! Animals use sound echoes to locate an object or prey.

Humans use echolocation, too, in ***sonar*** (sound thru water), ***radar*** (light waves thru air), and ***sonograms*** (sound waves thru the human body).

1. Timbre	A. Using reflected waves to "see".
2. Beats	B. How two sounds can have the same frequency, but different sounds.
3. Echo	C. Created by two frequencies that are very close to each other.
4. Echo-location	D. Changing of pitch because of a moving object.
5. Doppler Effect	E. A reflected sound.

6. In front (F), behind (B), or on the ambulance (O)?

A. ____ Pitch is lower?

B. ____ Pitch is higher?

C. _____ λ is longer?

D. _____ λ shorter?

E. _____ Speed of sound is greater?

F. _____ Pitch is the same (unchanged)?

7. What happens as it passes you?

8. Note 1 has a frequency of 185 Hz. Note 2 has a frequency of 189 Hz. How many beats do you hear?

9. f_1 = 366 Hz. There are 3 beats per second.
f_2 = ________ or ________.

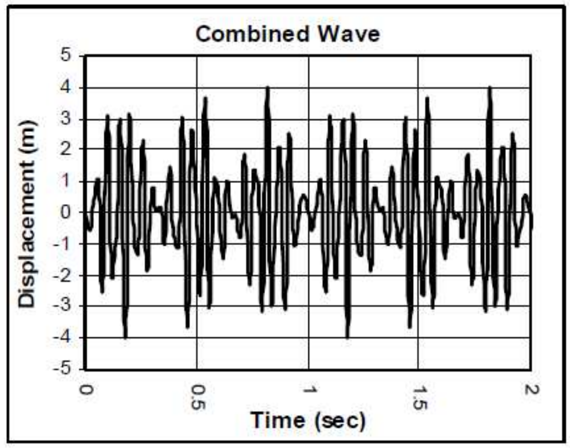
10. If you heard 4 beats before and now you hear 2 beats, are the notes more in-tune or out-of-tune?

11. Use the graph at the right to answer the following.

A. Mark constructive interference (C) and destructive interference (D).

B. How many beats are shown per second?

C. If f_1 = 592 Hz and f_2 is higher, what is f_2?



12. What helps us distinguish between two different instruments?

13. A clarinet and an oboe play the same note.

A. How do the fundamental frequencies of the two notes compare?

B. What is different between the two notes?

14. Which has higher harmonics: a bright note or a dark note?

15. A boat using sound to map the bottom of a deep lake. The instrument reads 115 m deep.

A. What kind of echolocation is being used?

B. How far do the sound waves travel to get back to the boat?

16. A person yelling into a canyon hears the echo in 1.4 seconds.

A. What is the speed of the yell?

B. How deep is the canyon?

17. A person claps their hands, the echo is heard 1.5 seconds later after it reflects off of a wall 254 m away. How fast is the speed of sound for that temperature, and pressure?

REVIEW:

18. Find the period of a pendulum with a length of 35 cm.

19. A mass of 600 g is placed on a spring. It stretches 18 cm. Find the spring constant of the spring.

20. A sound has a frequency of 550 Hz in air. Find wavelength.

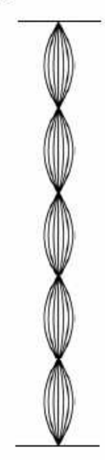
21. Use the picture at the right to answer the following:

A. If the string length is 2.8 meters, find the wavelength of this harmonic.

B. What is the wavelength of the fundamental?

C. Can we hear this frequency?

D. Find the wave speed of this string.



360 Hz