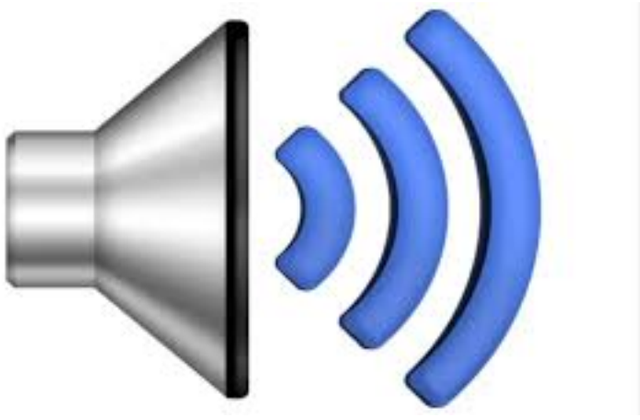


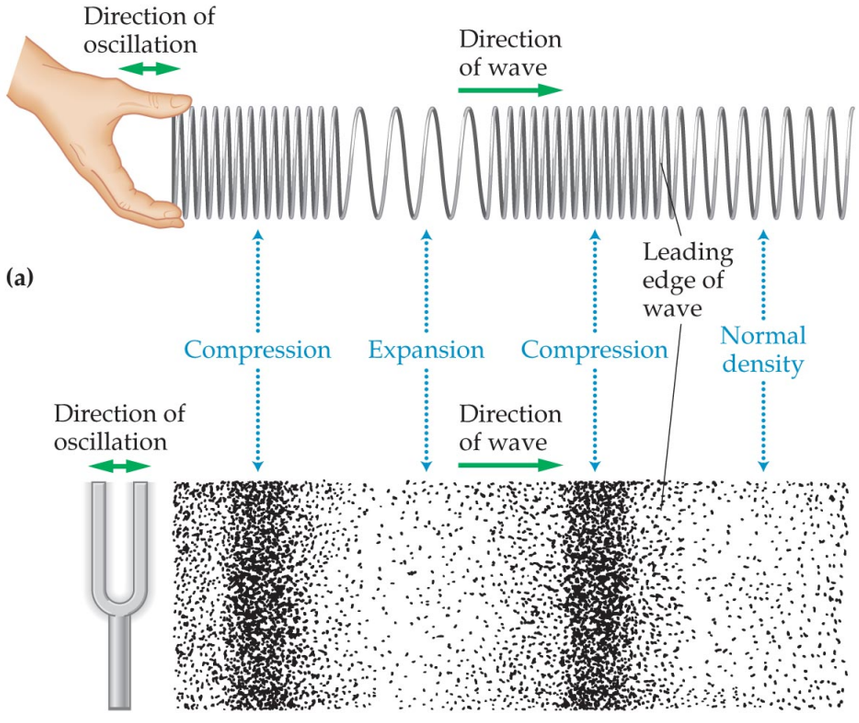
Chapter 14 - Sound

Sound - Longitudinal wave
Speed in air 331 m/s at 0 C
(Approximately 770 mi/hr)

Human Hearing range (frequency)
20 Hz - 20k Hz

Compressions and expansions
Regions of higher and lower pressure.

Longitudinal wave



os·cil·la·tion

n*oun* \ˌä-sə-ˈlā-shən\

: the act of regularly moving from one position to another and back to the original position

: a frequent change from one state, position, or amount to another

: the act of changing from one belief, feeling, etc., to an opposite one

A single oscillation = a single cycle

Sound travels by making molecules vibrate. Therefore it will not travel through a vacuum. The speed of sound depends upon the substance (the medium) and, to a certain degree, the temperature.

Table 15-1

Speed of Sound in Various Media

Medium	m/s
Air (0°)	331
Air (20°)	343
Helium (0°)	972
Water (25°)	1493
Seawater (25°)	1533
Copper (25°)	3560
Iron (25°)	5130

(This material is a reminder.)

Interference:

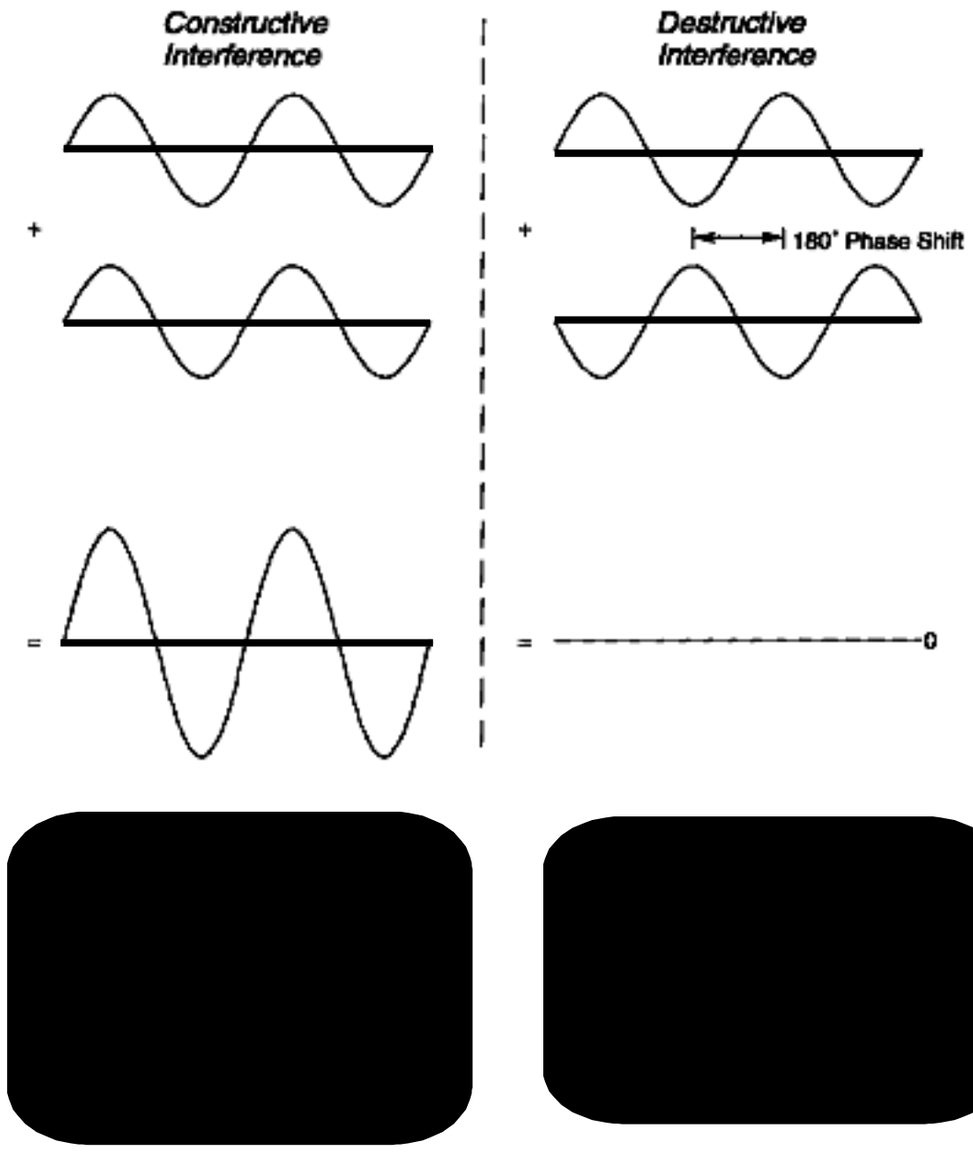
When two waves pass through the same region in space they add up as vectors.

Constructive Interference:

Two waves meet in phase (in step) and produce a wave of increased amplitude (loudness).

Destructive Interference:

Two waves meet out of phase (out of step) and produce a wave of decreased amplitude.


Constructive Interference
Destructive Interference
+
+
180° Phase Shift
=
=
0

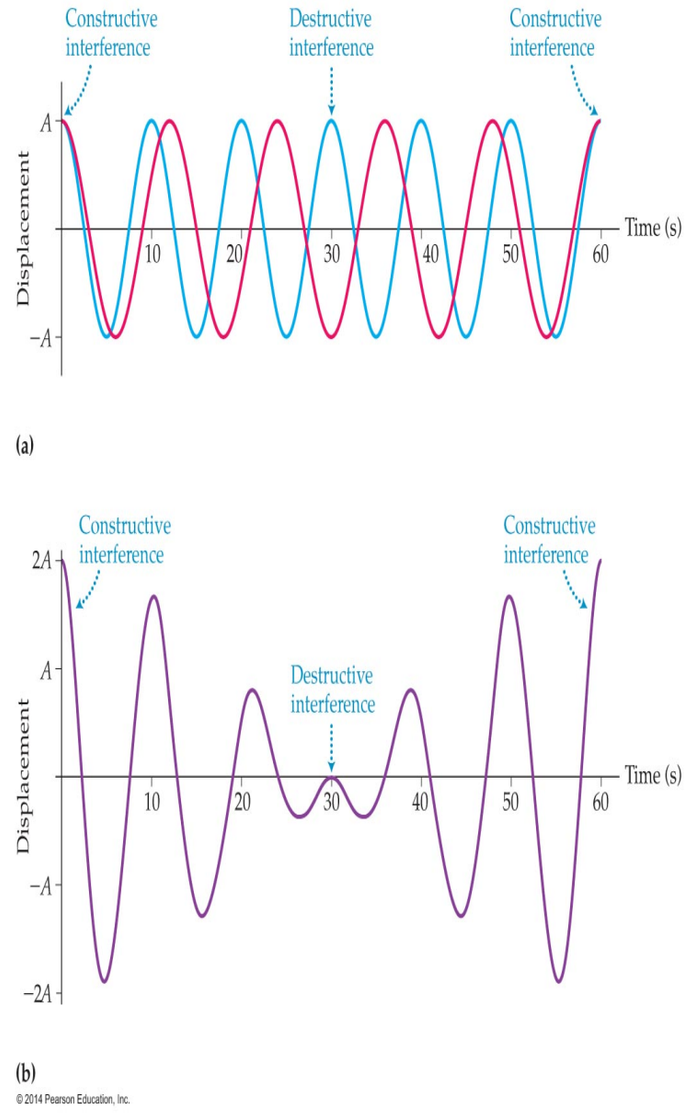
Q.

What happens if two waves of different frequencies meet?

A.

You get alternating constructive and destructive interference. This is called "BEATS"

The number of beats is equal to the difference between the two frequencies. For example, if you have 450 Hz and 452 Hz sounding together you will hear 2 beats per second.



You can play with this to generate beats.

http://ionaphysics.org/classroom/Physlets2/IonaPuzzles/ToneGenerator/Beats.htm

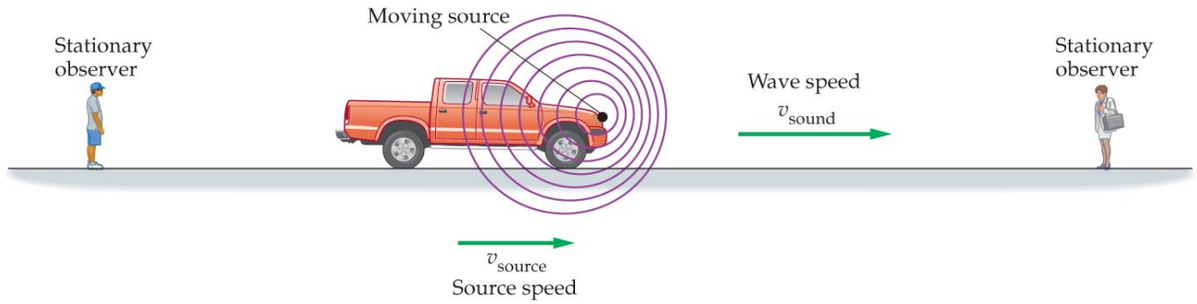
Homework on beats:

http://ionaphysics.org/classroom/lessons/Physics%20Homework%20on%20Beats.doc

Doppler Effect

Change in the observed frequency when there is relative motion between the source and the observer.

(Actual frequency of the source does not change.)



Sound

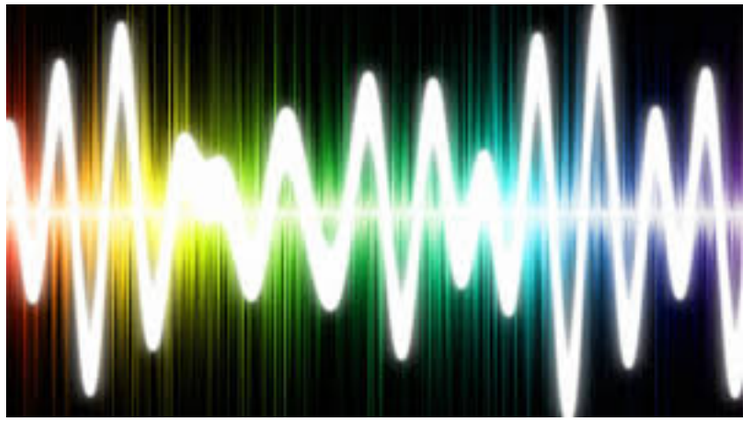
This should work on any web browser.
It is the sound of a car horn approaching then receding at 30 miles/hour

http://ionaphysics.org/lab/30mphdoppler.mp3

Here is a link to a good video about the doppler effect:
http://www.esa.int/spaceinvideos/Videos/2014/07/Doppler_effect_-_classroom_demonstration_video_VP05

Light is also doppler shifted if the source is moving relative to the observer.
It is shifted toward the red if the source and observer are separating. It shifts toward the blue if the source and observer are approaching each other.

Click Here for a good summary:



Sound intensity (loudness)

I = P/A

I=Intensity
P=Power
A=Area

(Point Source)
$I = P/(4\pi r^2)$

Table 14.2 Sound Intensities (W/m^2)

Loudest sound produced in a laboratory	10^{9}
Saturn V rocket at 50 m	10^{8}
Rupture of the eardrum	10^{4}
Jet engine at 50 m	10
Threshold of pain	1
Rock concert	10^{-1}
Jackhammer at 1 m	10^{-3}
Heavy street traffic	10^{-5}
Conversation at 1 m	10^{-6}
Classroom	10^{-7}
Whisper at 1 m	10^{-10}
Normal breathing	10^{-11}
Threshold of human hearing	10^{-12}