Doppler Effect

- You hear the high pitch of the siren of the approaching ambulance, and notice that its pitch drops suddenly as the ambulance passes you. That is called the Doppler effect.

\[
\Delta f = \frac{f_1 - f_0}{f_0} = \pm \frac{V}{v}
\]

a) \( +V \) for approach, 
b) \( -V \) for separation

A girl is sitting near the open window of a train that is moving at a speed of 10 m/s. The girl’s uncle stands near the tracks and watches the train move away. The girl’s brother also stands near the tracks but ahead of the train, and watches the train getting closer. The train is blowing a whistle with a frequency of 500 Hz. What frequency does the girl hear? Her uncle? Her brother?

Shock Wave

Wave interference is the phenomenon which occurs when two waves meet while traveling along the same medium.

The interference of waves causes the medium to take on a shape which results from the net effect of the two individual waves upon the particles of the medium.
Principle of Superposition

• When two waves interfere, the resulting displacement of the medium at any location is the algebraic sum of the displacements of the individual waves at that same location.

Superposition

Superposition

Interference and Phase

Two traveling waves which exist in the same medium will interfere with each other. If their amplitudes add, the interference is said to be constructive interference, and destructive interference if they are "out of phase" and subtract.

Constructive Interference

Destructive Interference
Destructive Interference

Before and After

The two circular waves undergo interference and create the pattern represented in the diagram. The thick lines in the diagram represent wave crests and the thin lines represent wave troughs. Several of positions in the water are labeled with a letter. Categorize each labeled position as being a position where either constructive or destructive interference occurs.

Interference with a Tuning Fork

• Each tine of the fork produces a pressure wave which travels outward at the speed of sound.
  – One part of the wave has a pressure higher than atmospheric pressure, another lower.
  – At some angles the high pressure areas of the two waves coincide and you hear a louder sound.
  – At other angles, the high pressure part of one wave coincides with the low pressure part of the other.

Interference of two identical sound

• Figure 4-13
• Figure 4-14
• Figure 4-15

Interference and Phase

• \( n \lambda = L_1 - L_2 \)
• \( n = 0, \pm 1, \pm 2, \pm 3, \pm 4, \ldots \)
  for constructive interference
• \( n = \pm 1/2, \pm 3/2, \pm 5/2, \ldots \)
  for destructive interference
Beats

- When two sound waves of different frequency approach your ear, the alternating constructive and destructive interference causes the sound to be alternatively soft and loud - a phenomenon which is called "beating" or producing beats.

Beats

Beat Frequency

- The beat frequency is equal to the absolute value of the difference in frequency of the two waves.
- \( f_{\text{beat}} = |f_1 - f_2| \)
- Used by musicians in tuning their instruments