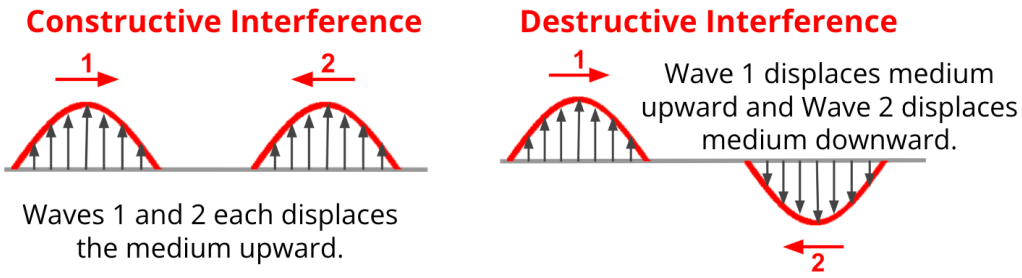
Sound Interference and Beats
Lesson Notes

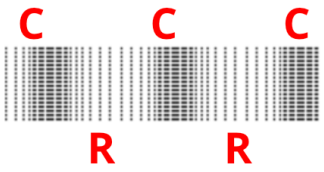
Learning Outcomes
- How do two sound waves interfere and what is the result?
- What role does sound interference play in the world of music?

Wave Interference
When two waves moving different directions in the same medium meet up with one another, **interference** occurs.



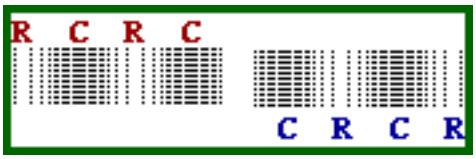
Each wave has their own individual influence upon the medium; but when they meet the medium momentarily takes on a shape that reflects the sum of each influence.

Sound Wave Interference
But wait! Sound waves don't have crests and troughs.



Compressions (high density regions) pull particles together; rarefactions (low density regions) push particles apart.

Constructive interference results when compressions meet compressions or rarefactions meet rarefactions. **Destructive interference** results when compressions meet rarefactions.



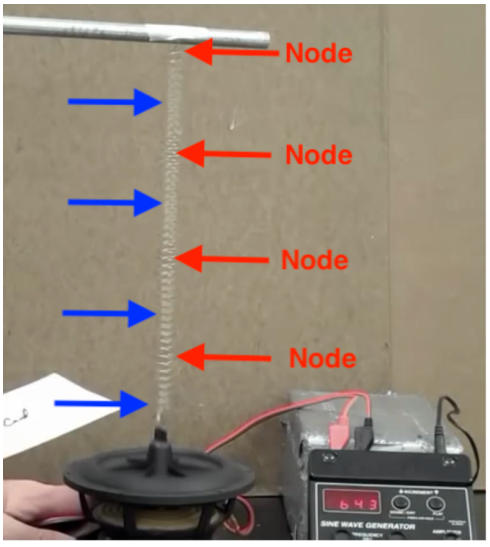
Longitudinal Standing Waves
Two longitudinal waves with just the right frequency and moving in opposite directions can interfere to produce a standing wave pattern.

Standing Wave: A wave pattern with permanently-positioned points that appear to be standing still.

Nodes = points of no displacement or no vibration. Locations where destructive interference always occurs.

Antinodes = points that are vibrating wildly.

For standing waves, the location of the nodes and antinodes are fixed.



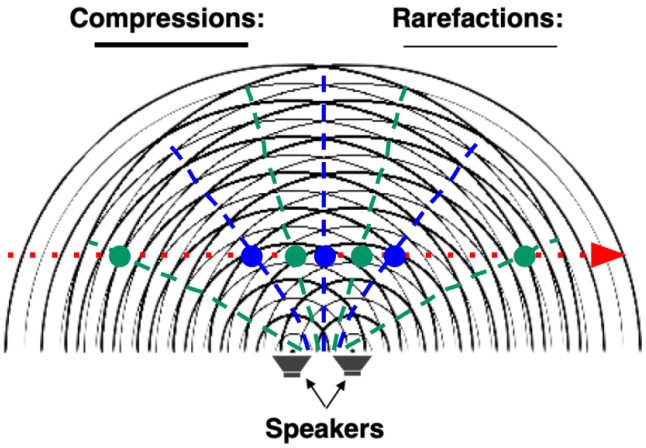
Two Source Sound Interference Patterns

Physics Experiment:

- 2 speakers playing the same frequency in large room
- Students walk slowly across the room … parallel to the line connecting the speakers
- What would they hear?

There is a pattern of antinodes aligned along lines

… and a pattern of nodes aligned along lines



Students would observe alternating **silent** (**nodes**) and **loud** (**antinodes**) locations as they walk across the room.

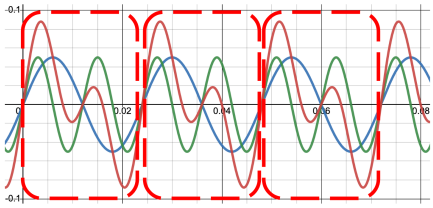
Interference and Music

- Music does not consist of one sound wave with a single frequency played continuously.
- For most instruments, when a sound of a desired frequency is produced, it is combined with **overtones** (less intense sounds with higher frequencies).
- The quality of music is enhanced when multiple sound waves interfere to produce a pleasant result.

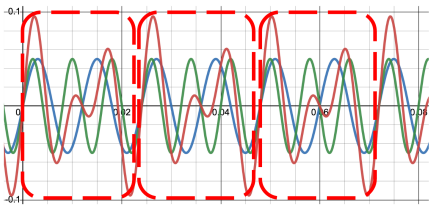
Pythagoras:

Music is not only pleasing to the ear but also to the mathematical mind.

Octave
2:1 f ratio
262 Hz
+
524 Hz



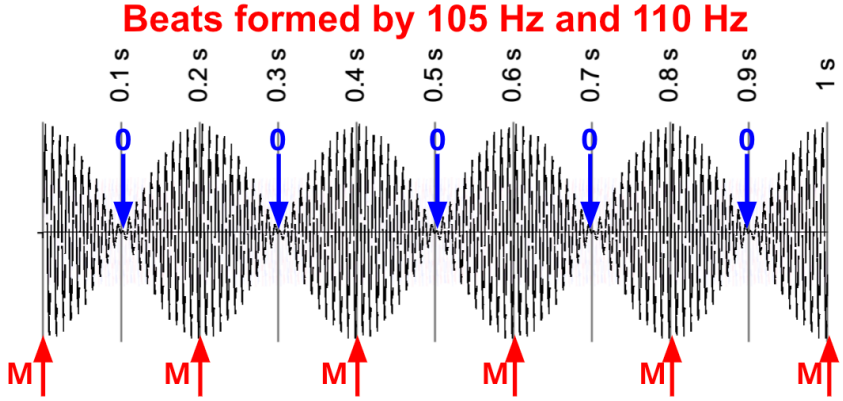
Fifth
3:2 f ratio
524 Hz
+
786 Hz



Musical Beats and Beat Frequency

Beats: Periodic and repeating fluctuations in the perceived intensity of a sound resulting from two sound waves of similar frequencies interfering over the course of time.

Observers would perceive the intensity fluctuating between **0** and **a maximum**.



Beat Frequency: the frequency at which these intensity fluctuations occur; it is the difference in frequencies of the two sound waves.