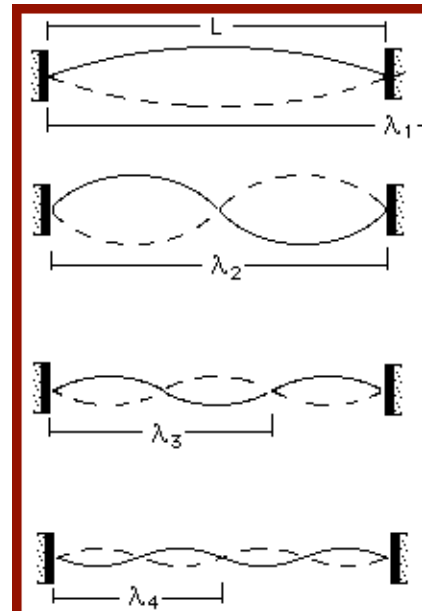


Waves/Sound Review Sheet

Waves transfer energy from place to place without moving mass from place to place (as particles do). Waves come in two types: Transverse (perpendicular oscillation) and Compression (Longitudinal)(parallel oscillation). Water waves are a combination of the two types, earthquake waves come in both types, slinkies can support both types, sound waves are compression waves, light waves are transverse oscillations (of electric fields).

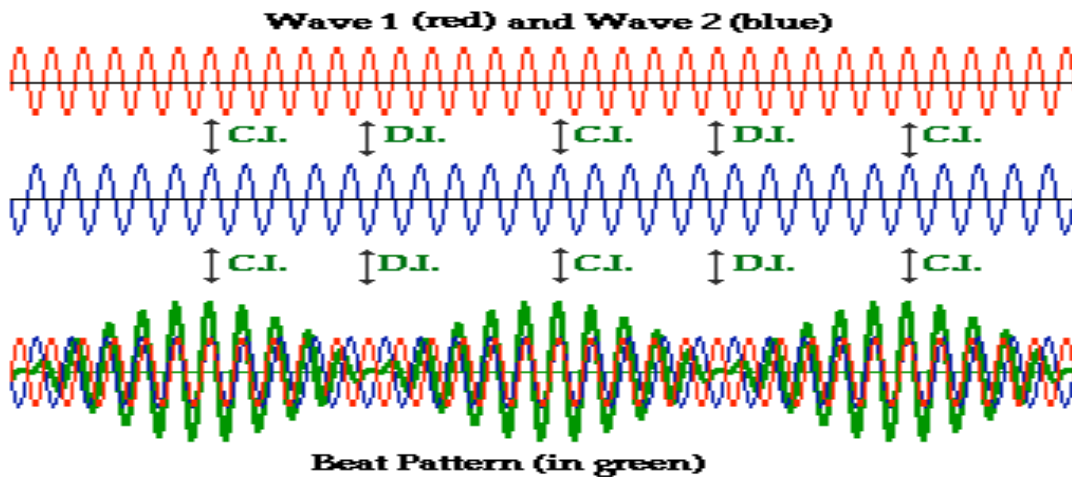
When waves overlap they interfere (their amplitudes add). Constructive and destructive interference occur, sometimes establishing patterns.

When a wave interferes with its own reflection a “standing wave” is formed, with nodes (areas of no movement) and antinodes (areas of maximum movement). Standing waves can serve as a source of traveling waves (for example, a guitar string when it’s plucked is a standing wave which is the source of sound waves). Waveforms of the closed-closed fundamental and the next three harmonics are drawn to the right-note each “bump” is $\frac{1}{2}$ of a wavelength). Open-closed and open-open waveforms are also possible.



Resonance is when an object with a natural frequency is forced to vibrate because of energy being added to the object at its natural frequency. Think of a child being pushed on a swing, or one tuning fork vibrating when another one of the same frequency is struck.

“Beats” occur when two very close frequencies are sounded together and you get a loud-soft (wah-wah-wah-wah) effect. A diagram is included below:



All waves retain their frequency when they go from medium to medium, with their speeds and wavelengths adjusting accordingly. Sound generally moves more quickly in liquids than in gasses, and even more quickly in solids. Light slows down in clear solids and liquids, and moves most quickly in a vacuum. Sound cannot travel at all in a vacuum (making all “space-war” movie explosions inaccurate—they should be totally silent).

Sound intensity is measured in Watts/m², but usually expressed in decibels. The decibel scale is logarithmic, meaning that each increase of 10 dB represents a sound that is 10 times louder. For example, if 1000 identical singers make a sound of 80 dB, each singer is making a sound of 50 dB. Sound intensity decreases as the SQUARE of the distance (inverse square law). For example, if a listener moves 100 times further away from a sound source, the sound becomes 10,000 times less intense.

The Doppler effect in sound describes the frequency heard when a sound source is moving or the listener is moving. If the source moves toward the listener or the listener moves toward the source, the sound frequency is increased (pitch gets higher, usually by a few Hz in the musical range). The effect is based on speed, not distance. There is a similar Doppler effect for light where objects moving apart rapidly (such as stars) have their perceived light shifted to lower (redder) frequencies.

Vowel sounds and musical “timbre” (TAM-ber) are produced by different wave shapes—the rounder the wave, the less harsh the sound.

Lab review—we measured the speed of sound in air using an open-closed air tube where the length of the shortest resonating tube was ¼ wavelength (why?). Knowing the frequency of the sound source (a tuning fork) and the length of the wave (4 times the length of the shortest resonating tube) we could determine the speed of sound using the most important wave relationship:

$$v = f \cdot \lambda$$

Waves move faster on tighter strings and slower on heavier strings. Shortening a string raises the pitch, as does tightening the string or using a lighter string.

Open Closed and Open-Open Waveforms:

