

Sound

- What is Sound?
- Wave Analysis
- Characteristics of waves

Bring Headphones to Class on Thursday 2/23/2012

What is Sound???

Two Types of Waves:

1) Electromagnetic Wave

2) Mechanical Wave:

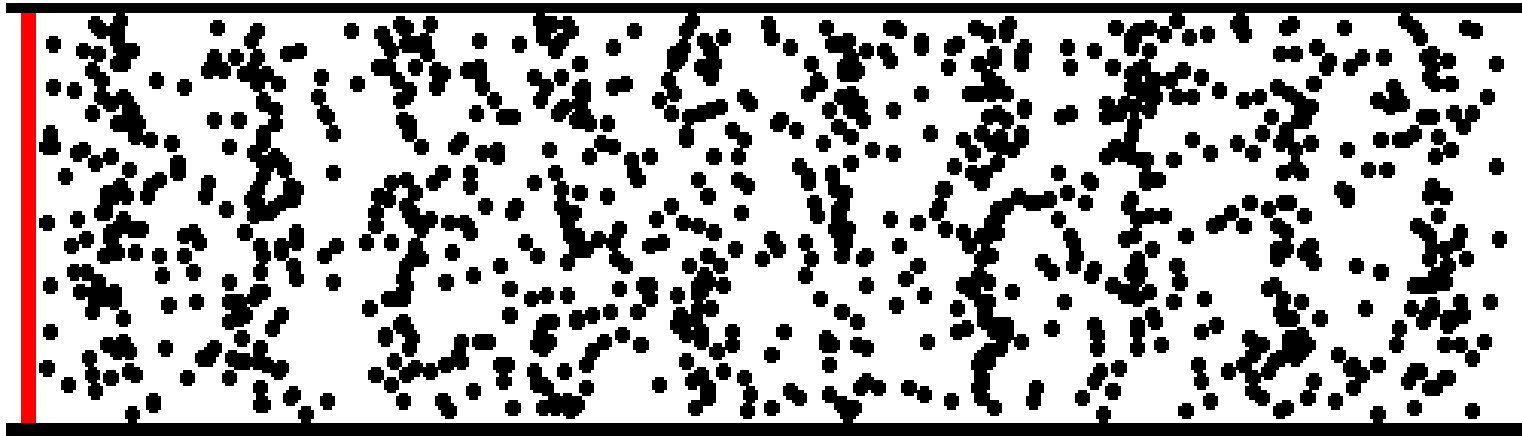
Disturbance that must travel through a medium which transports energy from one location to another

Medium: gas, liquid, or solid.

No Medium = No Mechanical Wave

Sound is a mechanical wave.

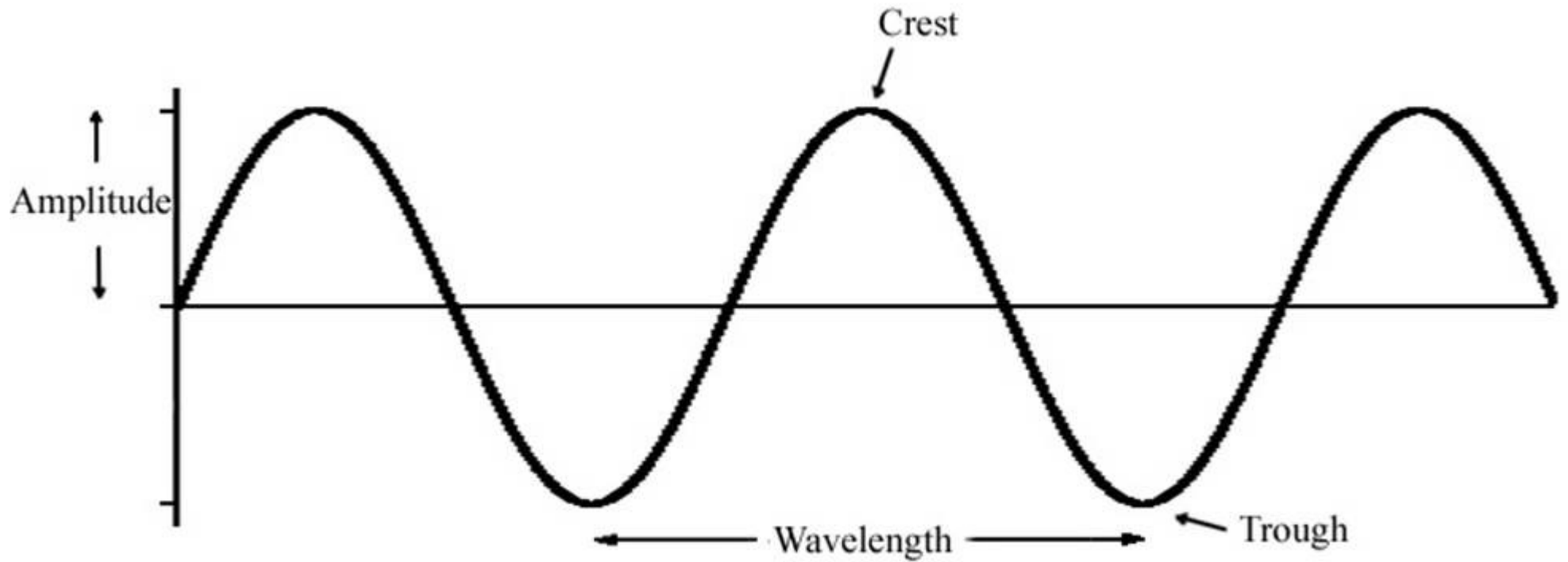
Sound waves propagate as a longitudinal wavefront



Longitudinal Wavefront:

Waves that move parallel to their direction in which the medium is disturbed as areas of compression (high pressure) and rarefaction (low pressure.)

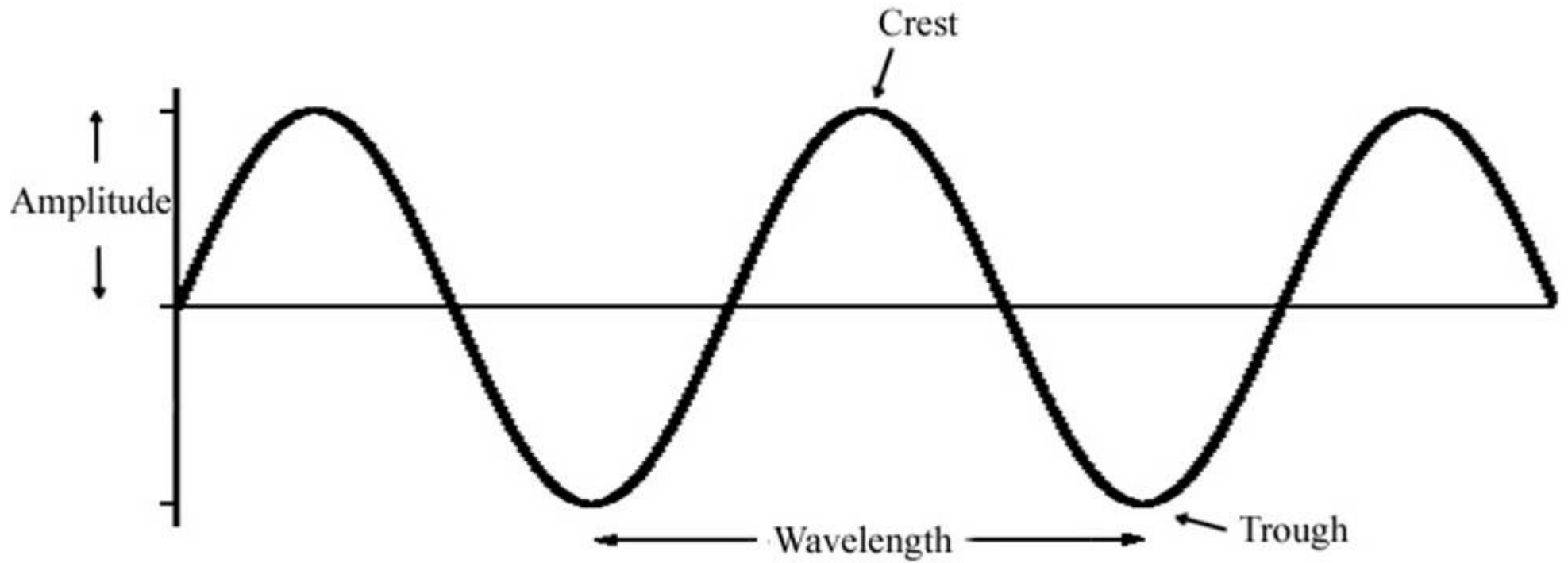
Wave Analysis



Crest: Highest area of a sinusoidal graph which corresponds to compression

Trough: Lowest area of a sinusoidal graph which corresponds to rarefaction.

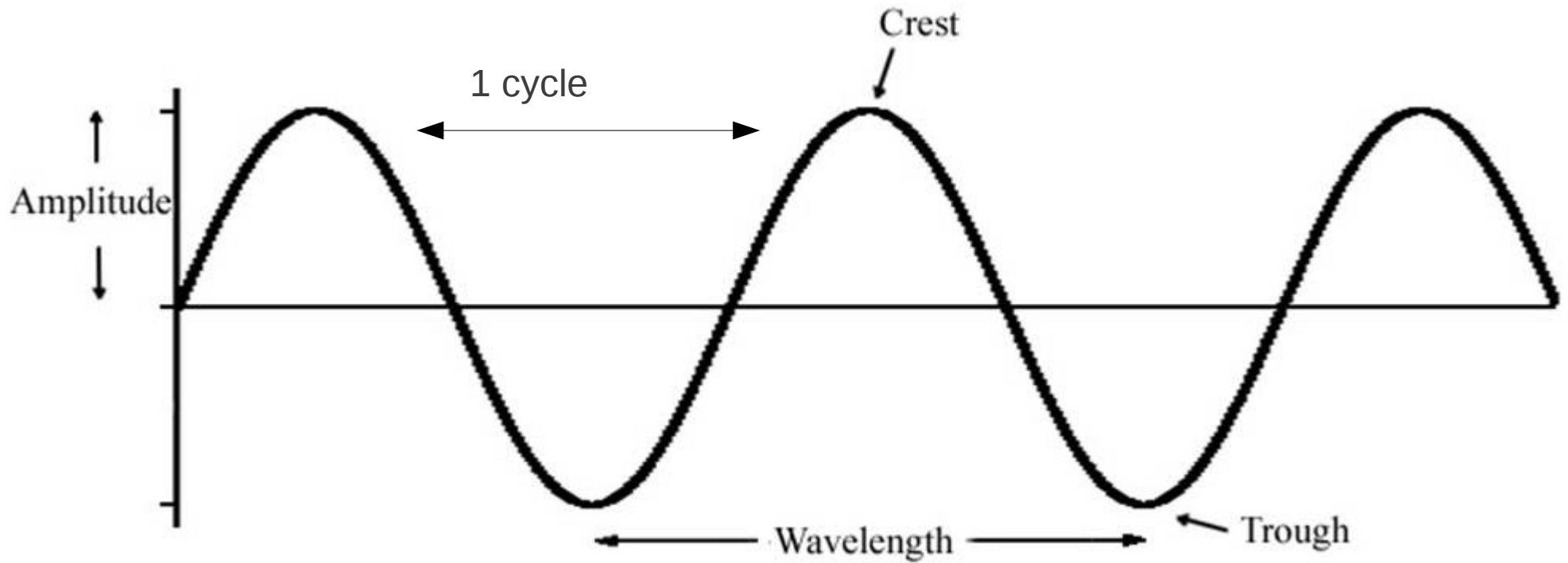
Wave Analysis



Wavelength:

Distance between either two adjacent troughs or two adjacent crests. (nm,cm,m)

Wave Analysis



One Cycle:

One complete vibration from crest to crest.

Frequency:

The number of cycles that occur in one second.

Unit: Hertz, (Hz)

Wave Analysis

Pitch:

The difference in frequency of a sound. Large number frequency will sound high to the human ear and small number frequency will sound low to the human ear.

Human hearing range: 20 Hz – 20,000 Hz

Wave Analysis

To Find the frequency/tone of a sound from a sinusoidal wave:

1) Find the period of a sample of the sound.

Period:

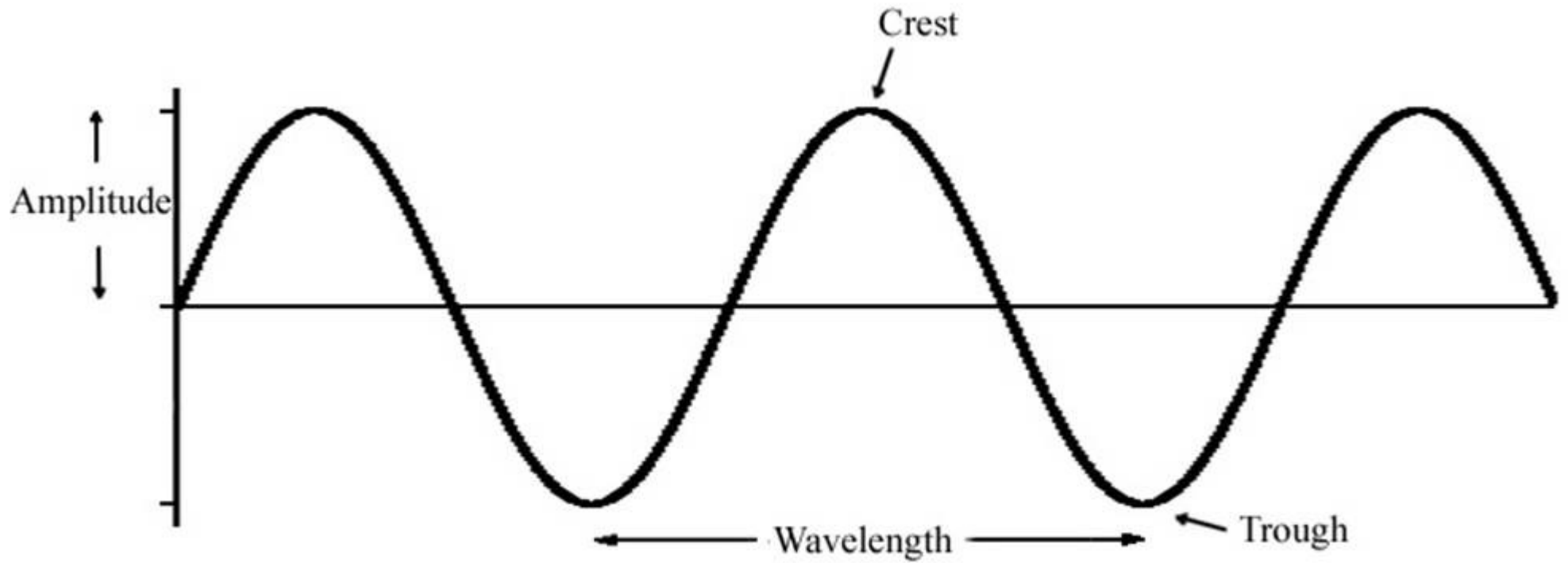
Number of seconds per cycle.

$$T = \frac{\textit{total time for } n \textit{ cycles}}{\textit{Number of Cycles}}$$

2) Find the frequency by taking the inverse of the period:

$$f = \frac{1}{T}$$

Wave Analysis



Amplitude:

Height of a crest or depth of a trough which indicates the intensity of a sound.

Intensity vs. Loudness

Intensity:

Rate at which the energy of the sound wave is carried through an area

Loudness:

Subjective and is based on intensity, medium, and distance from source.

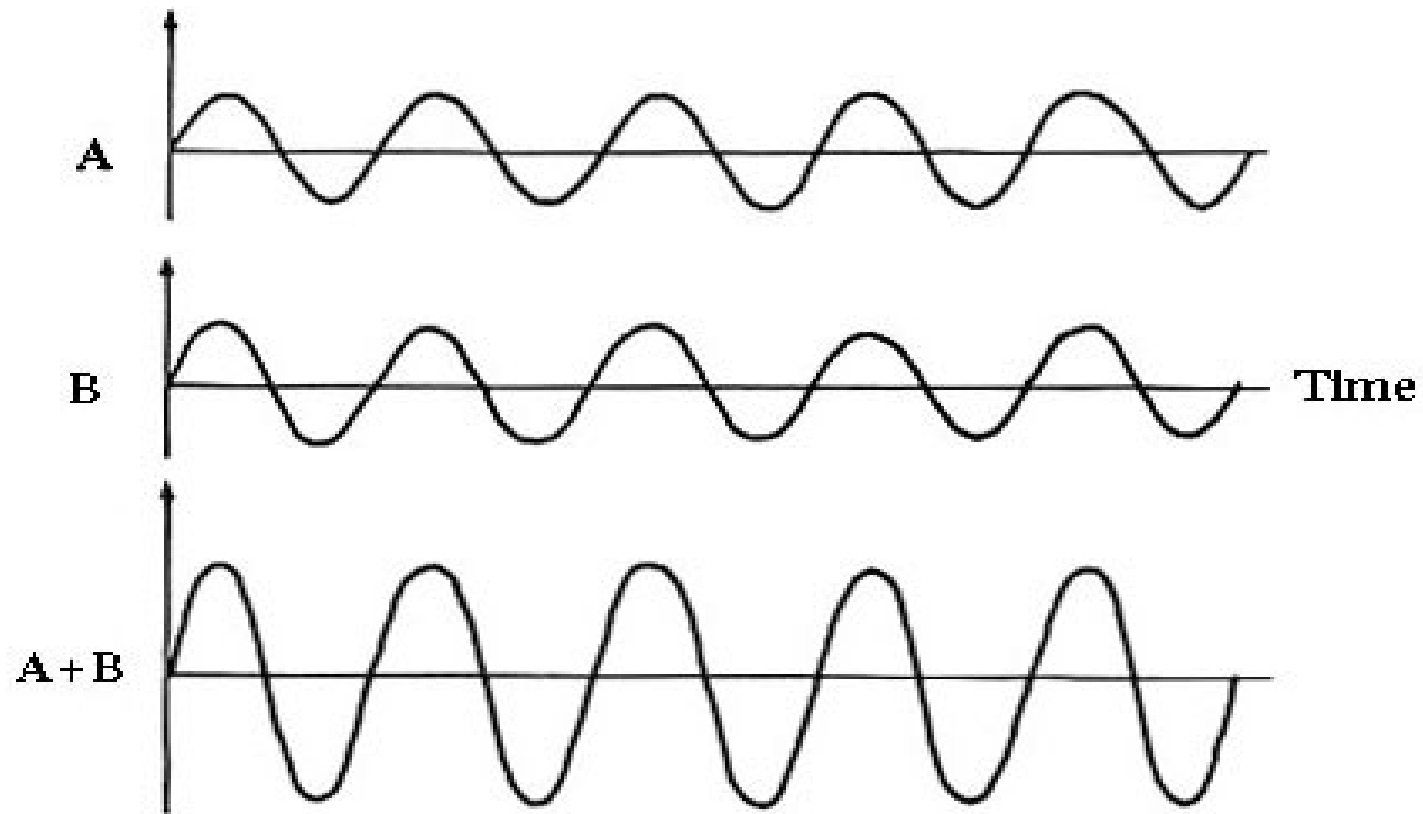
Decibel Scale: (db)
 Measures the intensity level of sound to the threshold of hearing.

Each level is a factor of 10 more than the level before it in intensity.

COMPARISON OF SOUND PRESSURE LEVELS AND LOUDNESS SENSATIONS

Sound Pressure Level (dBA)	Source	Sensation
130	Jet Aircraft at 100' Bass Drum at 3' Auto Horn at 3'	Physical Pain
120	Thunder, Artillery Nearby Riveter	Deafening
110	Elevated Train Discotheque	
100	Loud Street Noise Noisy Factory	Very Loud
90	Truck Unmuffled Police Whistle	
80	Cocktail Party Noisy Office Average Street Noise	Loud
70	Average Radio Average Factory	
60	Noisy Home Inside General Office	Moderate
50	Conversation Quiet Radio	
40	Quiet Home Private Office	Faint
30	Empty Auditorium Quiet Conversation	
20	Rustle of Leaves Whisper Soundproof Room	Very Faint
10		
0	Threshold of Audibility	

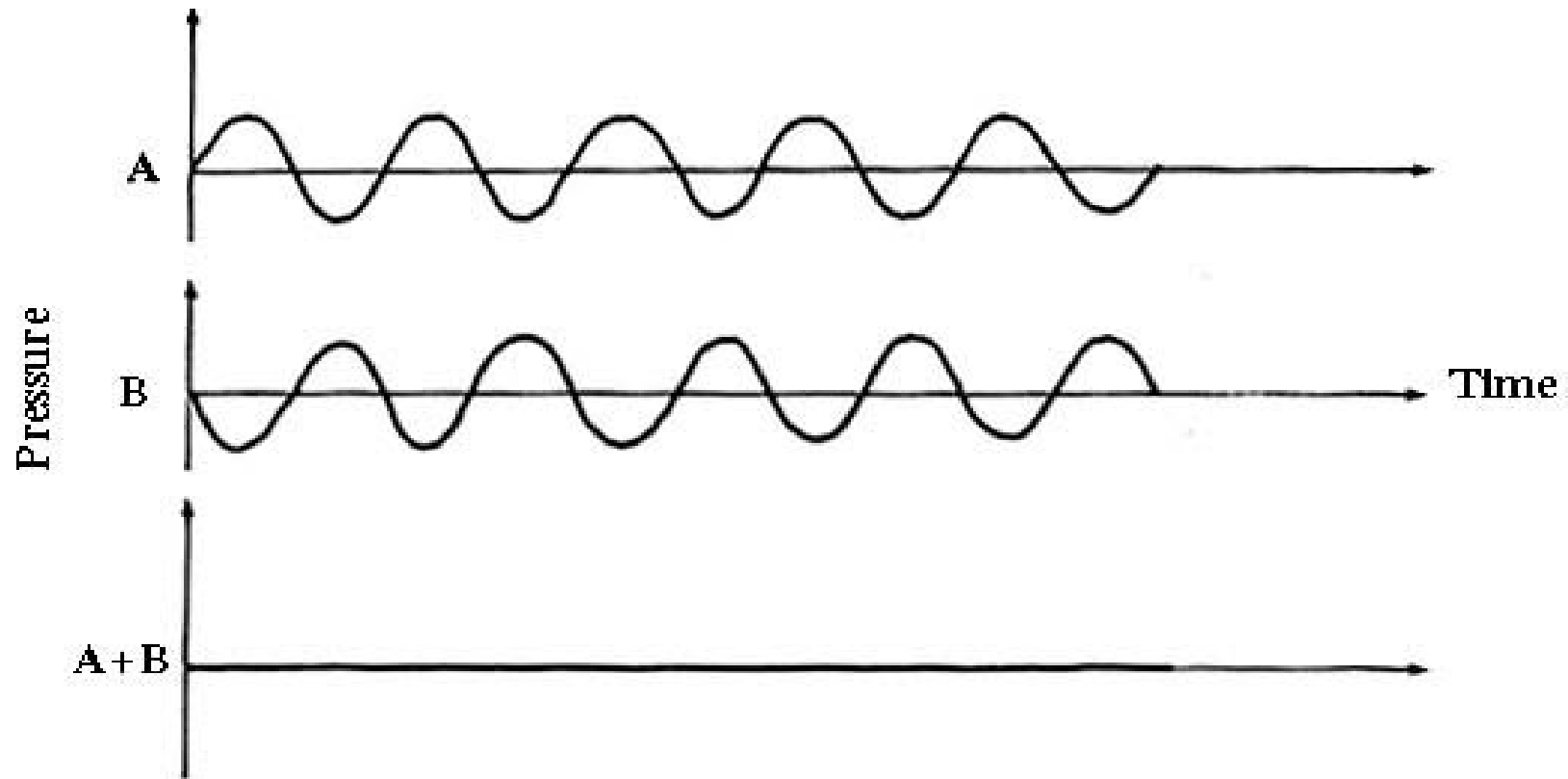
Characteristic Waves



Constructive Interference:

Crests and troughs of two or more signals line up and the result is a larger amplitude and more intense sound.

Characteristic Waves



Destructive Interference:

Crests of one wave line up with the troughs of another wave and the result is a smaller amplitude and less intense sound (or no sound.)

Beats:

Rhythmic increase and decrease from the constructive and destructive interference between two waveforms with slightly different frequencies.

- Produces a third tone.

How to use your voice to break a glass!

Resonance:

The ability for an object to be driven to vibrate at a larger amplitude.

Fundamental Frequency:

Lowest possible frequency that an object will produce an organized vibratory pattern.

- glass can be broken if made to resonate at the fundamental frequency (don't try this at home.)

Harmonics:

Multiples of the fundamental frequency.

- bridges can be destroyed if the wind sets up a harmonic.

Speed of Sound

Speed of sound dependent on:

- medium
- temperature

Velocity of sound = $331\text{m/s} + (0.6 * \text{Temperature})$