TECH 101

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Review of Last Class

- Defining electronic music: ***techniques*** **+ technology + concepts**
- "Purely Electronic Music"/ Synthesized Music / ("Elektronische Musik")
  - Analog vs. Digital
- "Electroacoustic Music" / ("Musique Concrète")
  - Live vs. Fixed ("acousmatic")
- Listening to electroacoustic music


empreintes DIGITALes
NATASHA
BARRETT
Isostasie
NATASHA BARRETT
PEAT+
POLYMER
AURORA
Natasha Barrett
Trade Winds

Racing Through, Racing Unseen (1996)

What sounds do you hear in this work?

What techniques does it seem were used to create these sounds (microphones, computer, instruments, etc.)?

Do these sounds evoke (a) location(s) or place(s)?

How is the work organized; how does it change over time?


What is Sound?

SOUND & SOUND

Sound refers to both what is perceived (a sensation) and to the stimulus that suggests the sensation (a physical phenomenon involving vibrations and energy)

Subjective & Objective

Psychoacoustics & Acoustics

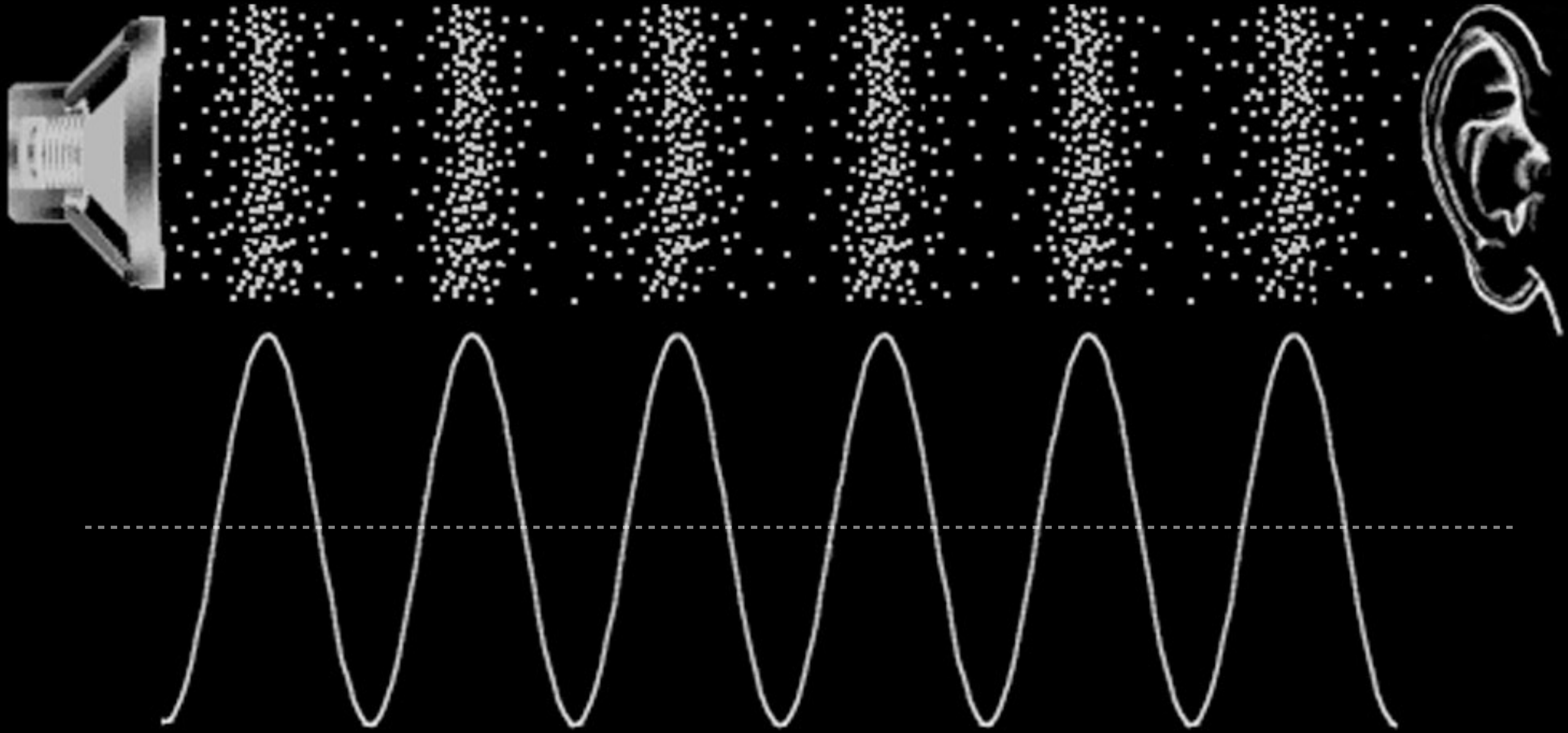
Examining the Phenomenon of Sound

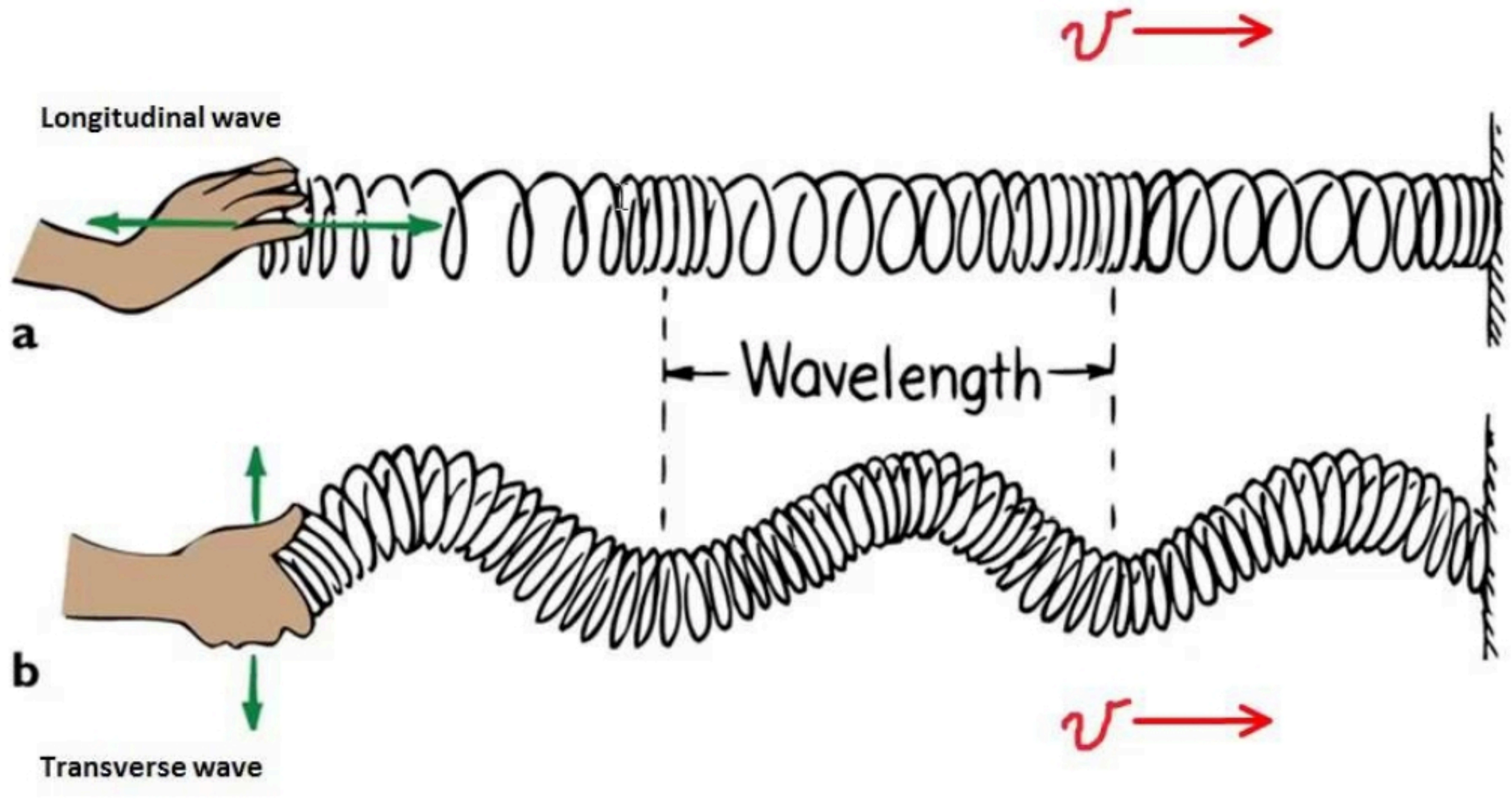
What is it physically?

How do we quantify or measure it?

How is it interpreted as sensations?

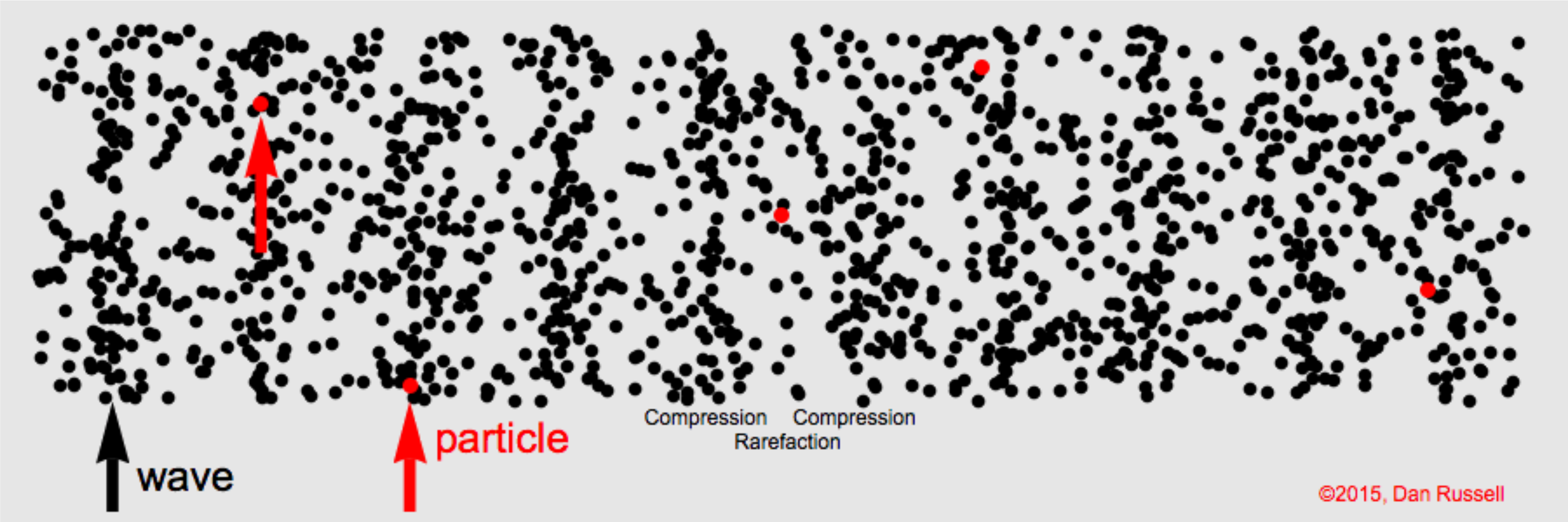
longitudinal waves of acoustical energy caused by air compression and rarefaction

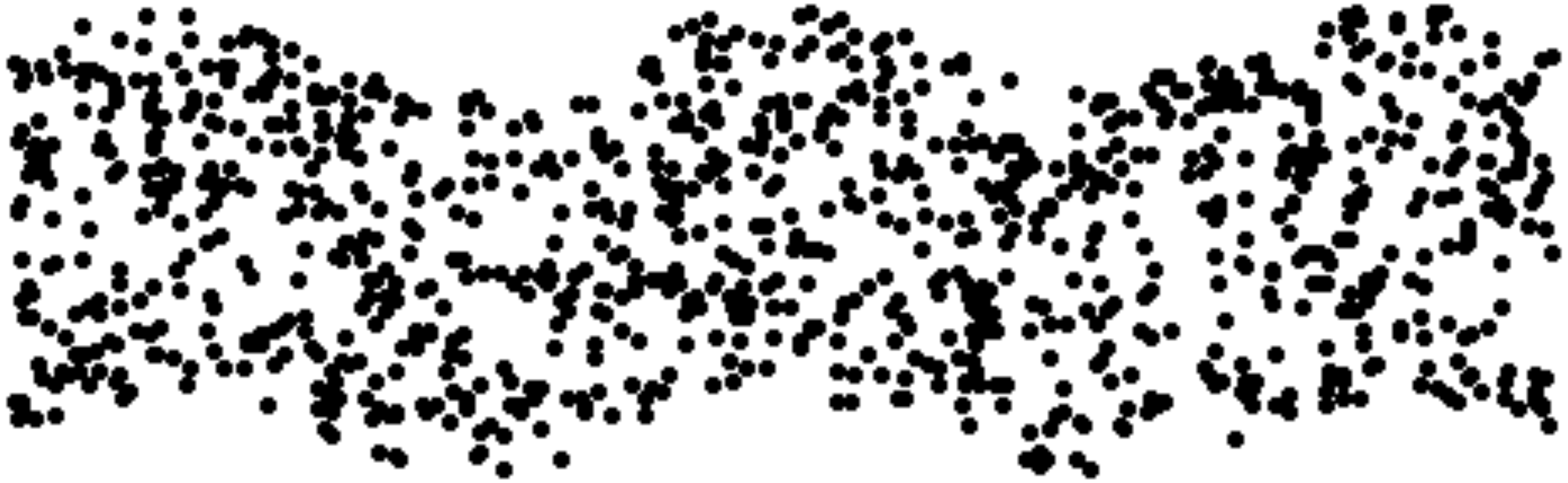




Sound travels through a longitudinal wave in a medium (usually air).

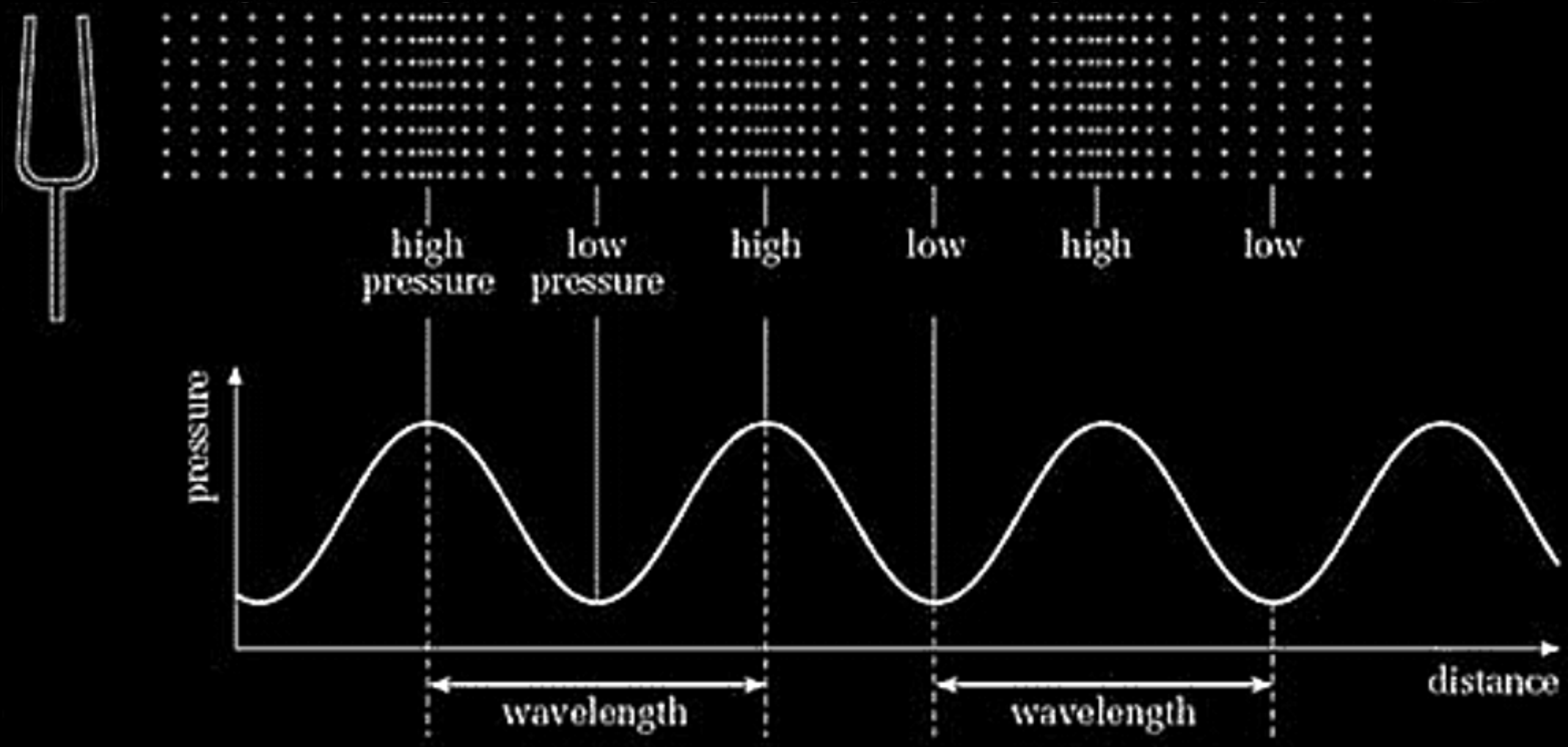
Longitudinal Wave (parallel with medium)

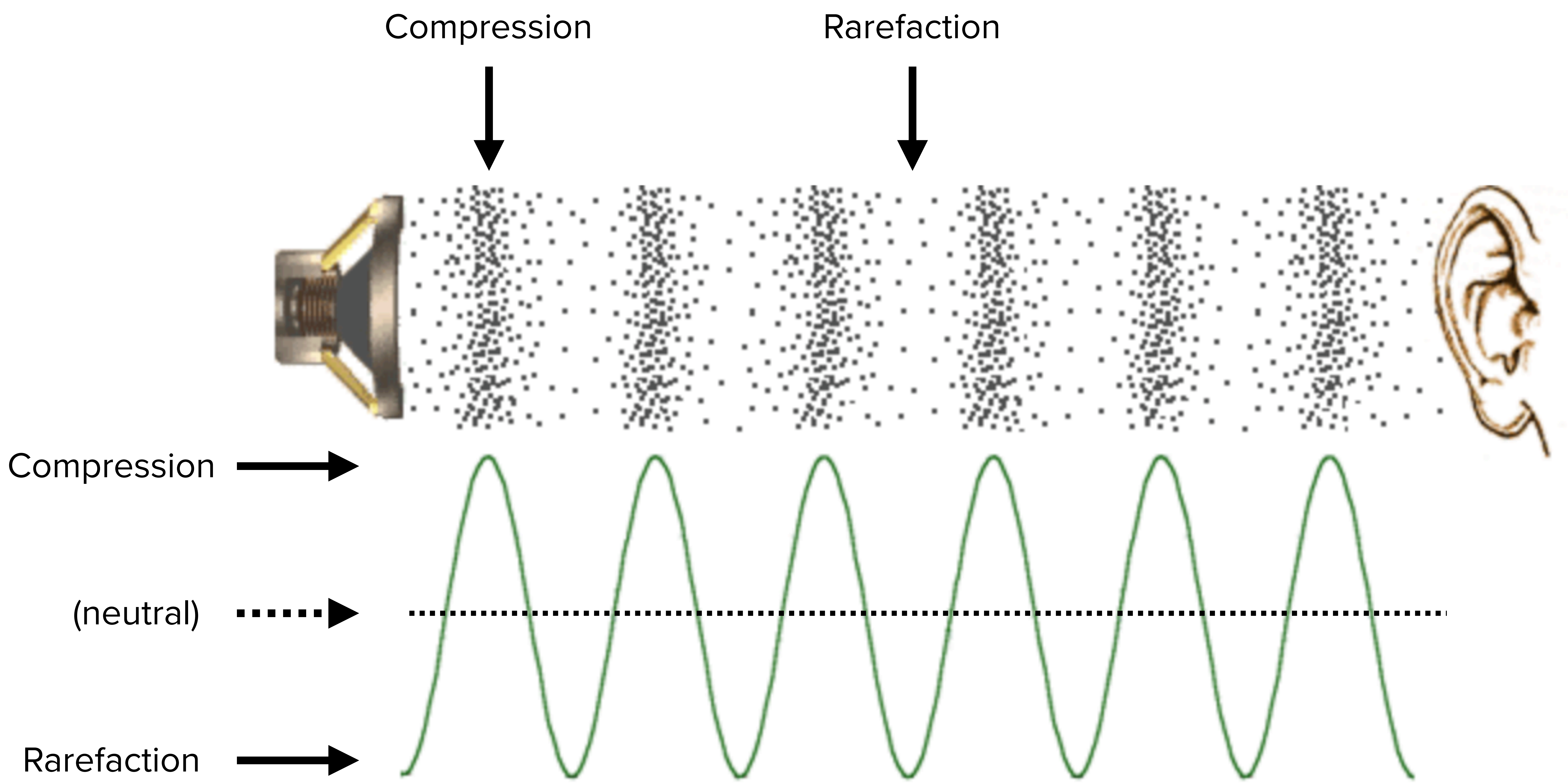




Transverse Wave (perpendicular to medium)

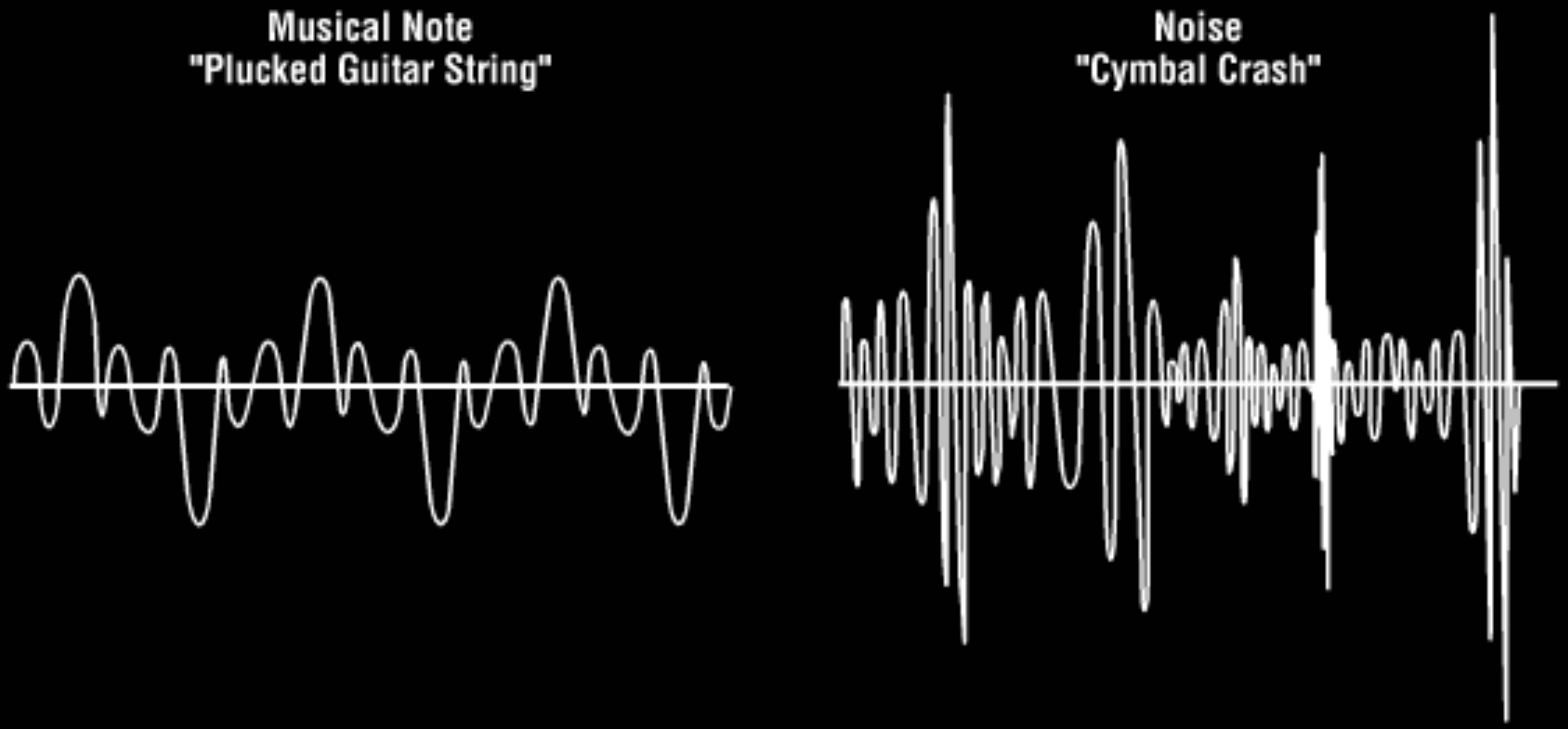
Graphing a Periodic Sound Wave





Compression
Rarefaction
Compression
(neutral)
Rarefaction

Periodic vs Aperiodic



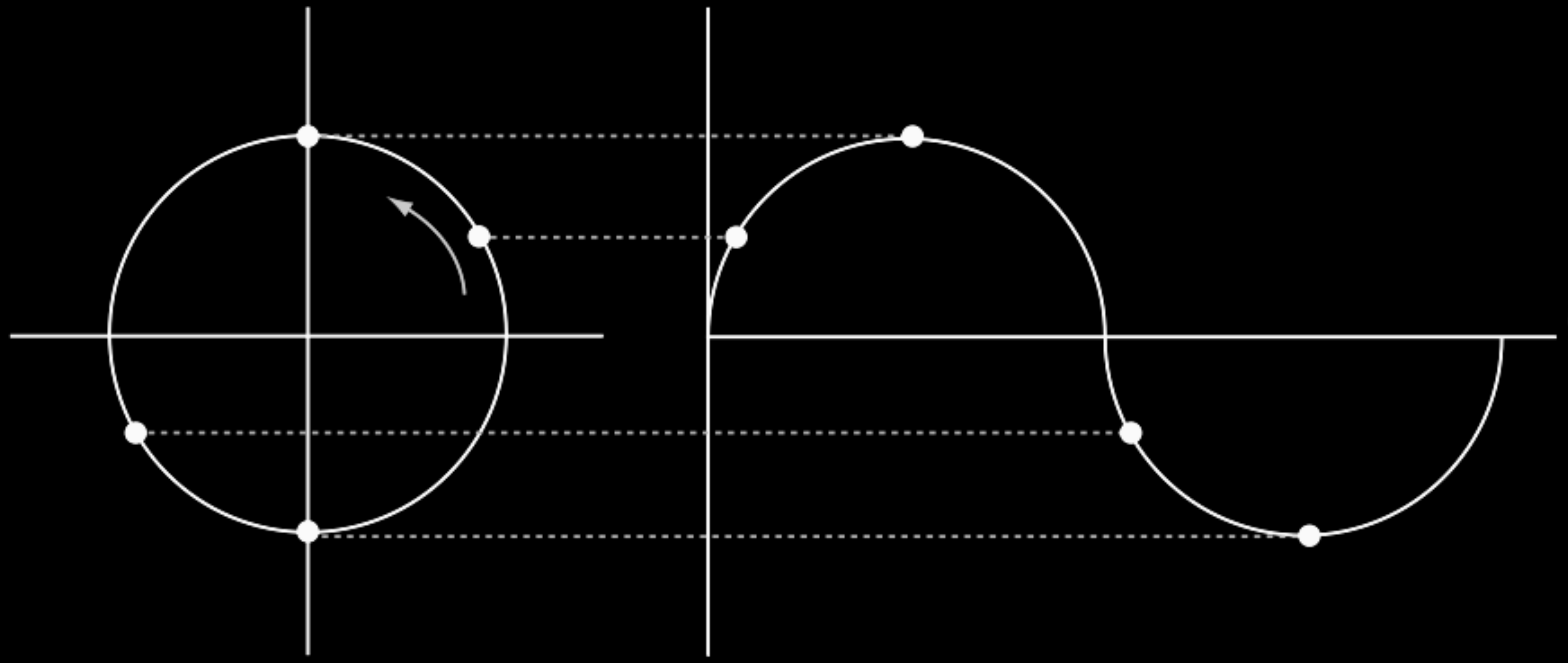
PSYCHOACOUSTICS		ACOUSTICS
LOUDNESS	⟷	AMPLITUDE
PITCH	⟷	FREQUENCY
QUALITY	⟷	TIMBRE

Sinusoidal Waves

Sine wave: a circular/smooth oscillation

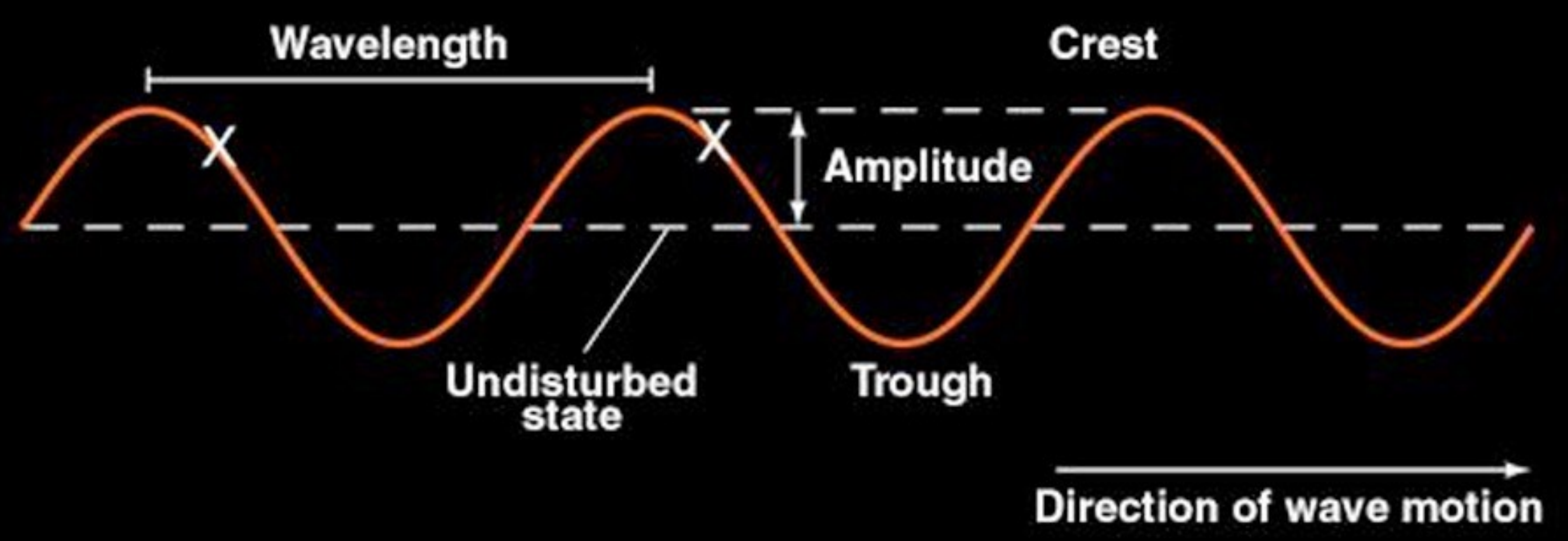
makes for a good oscillation (frequency) reference

pure sine waves are rarely found in nature

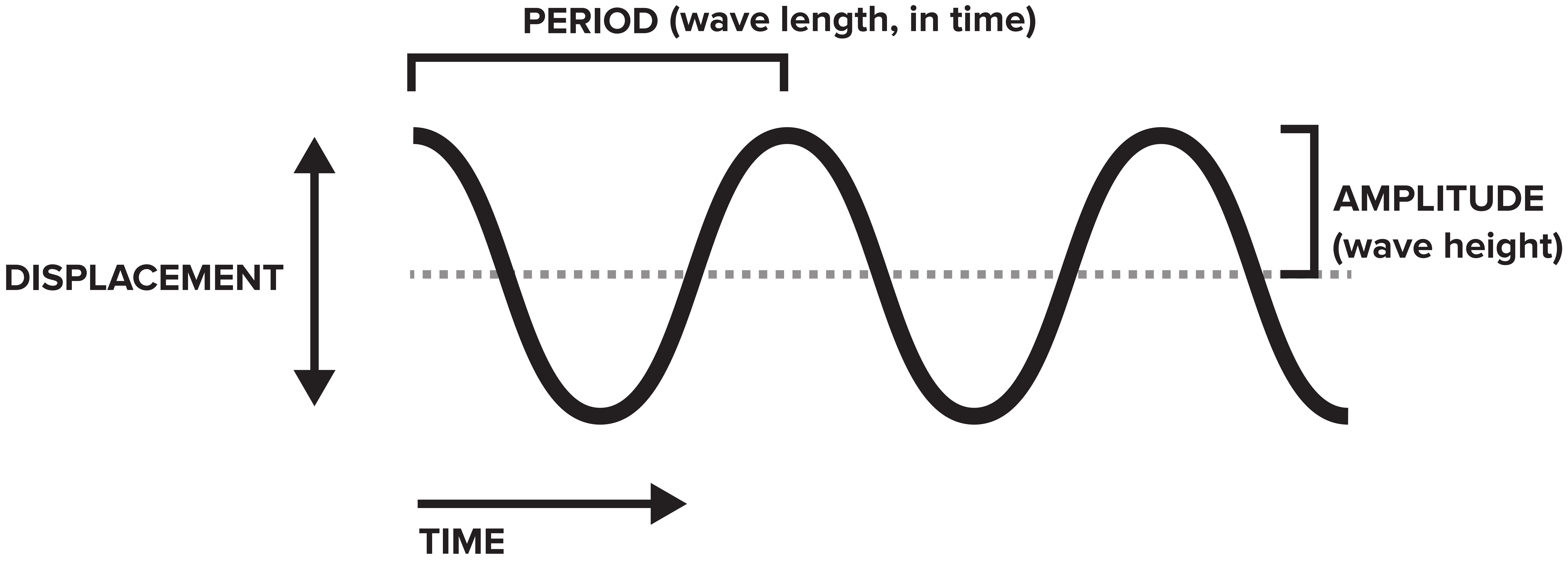


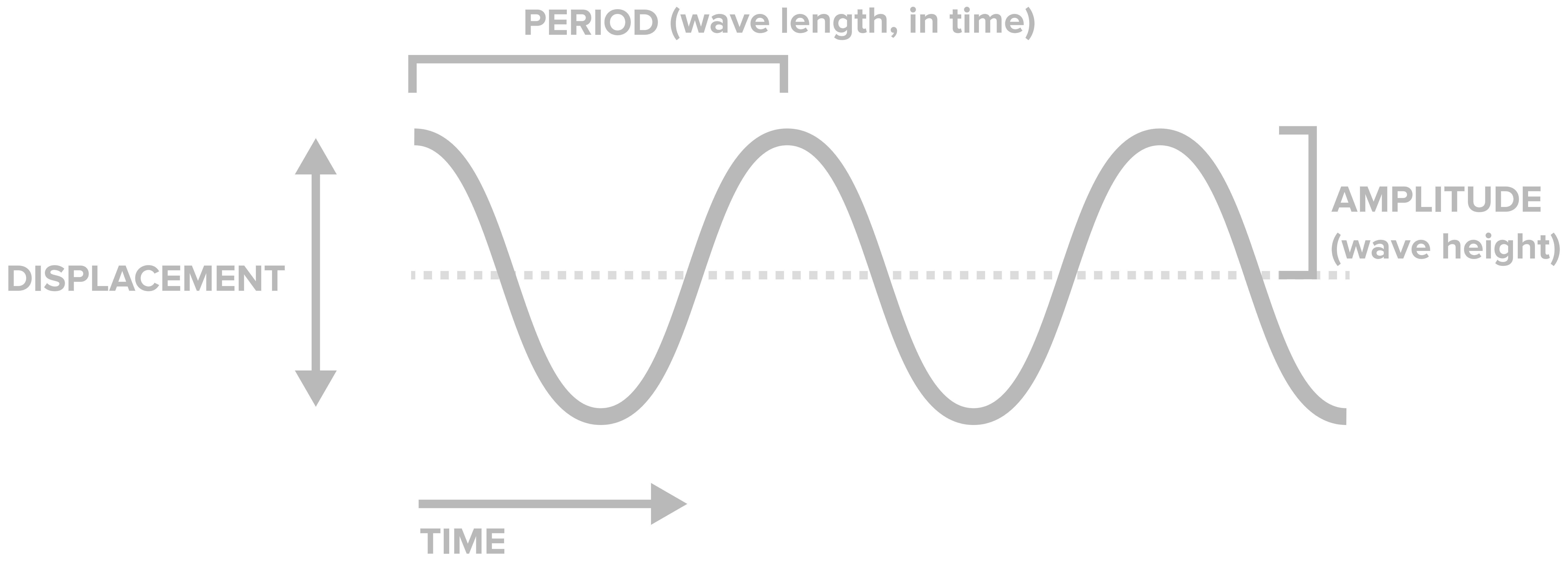
Reading a Periodic Waveform

Pressure

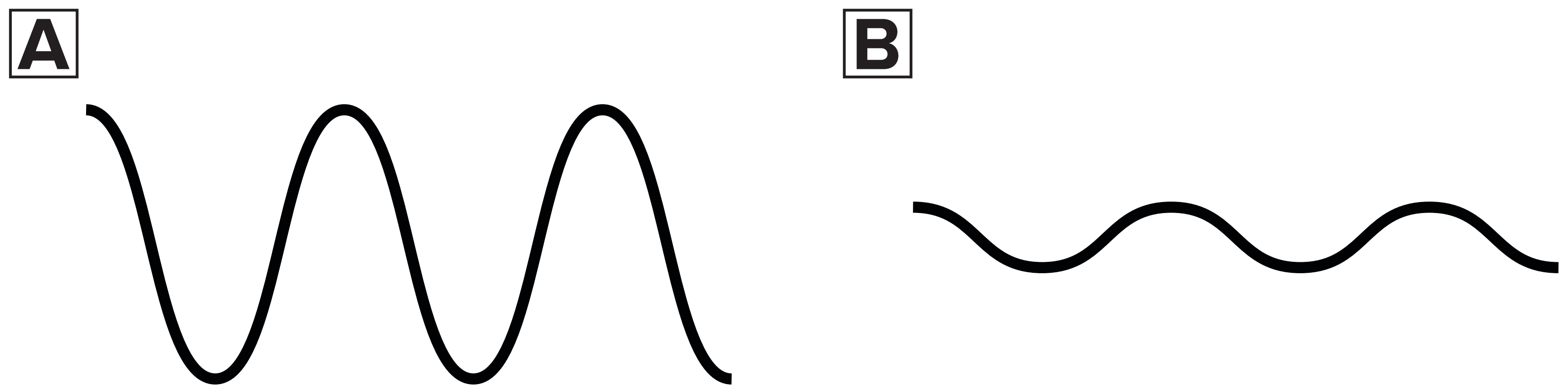


Distance (sometimes time)


PERIOD (wave length, in time)
DISPLACEMENT
AMPLITUDE
(wave height)
TIME

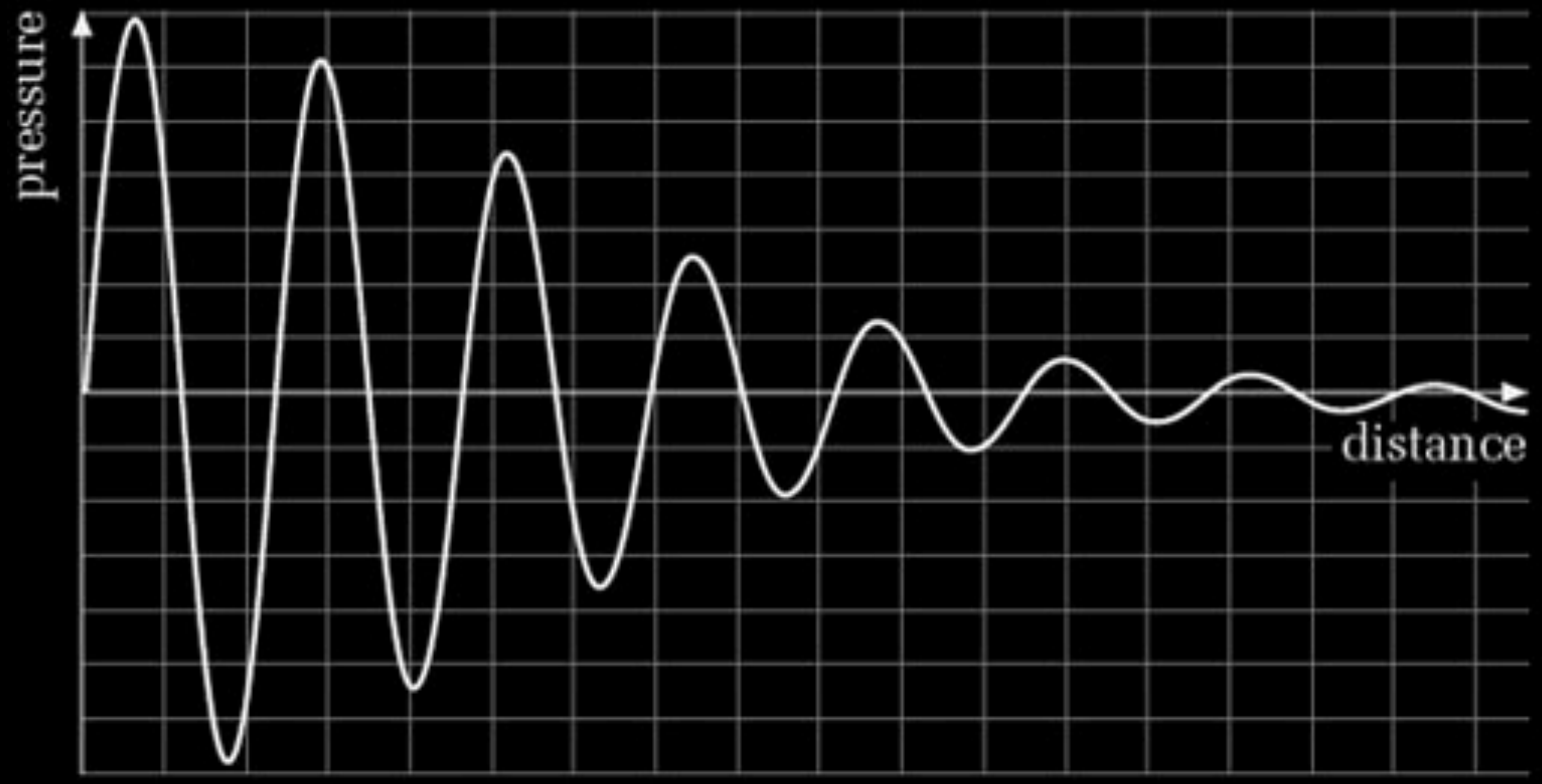


FOCUS ON AMPLITUDE



A has a greater amplitude than B

Amplitude



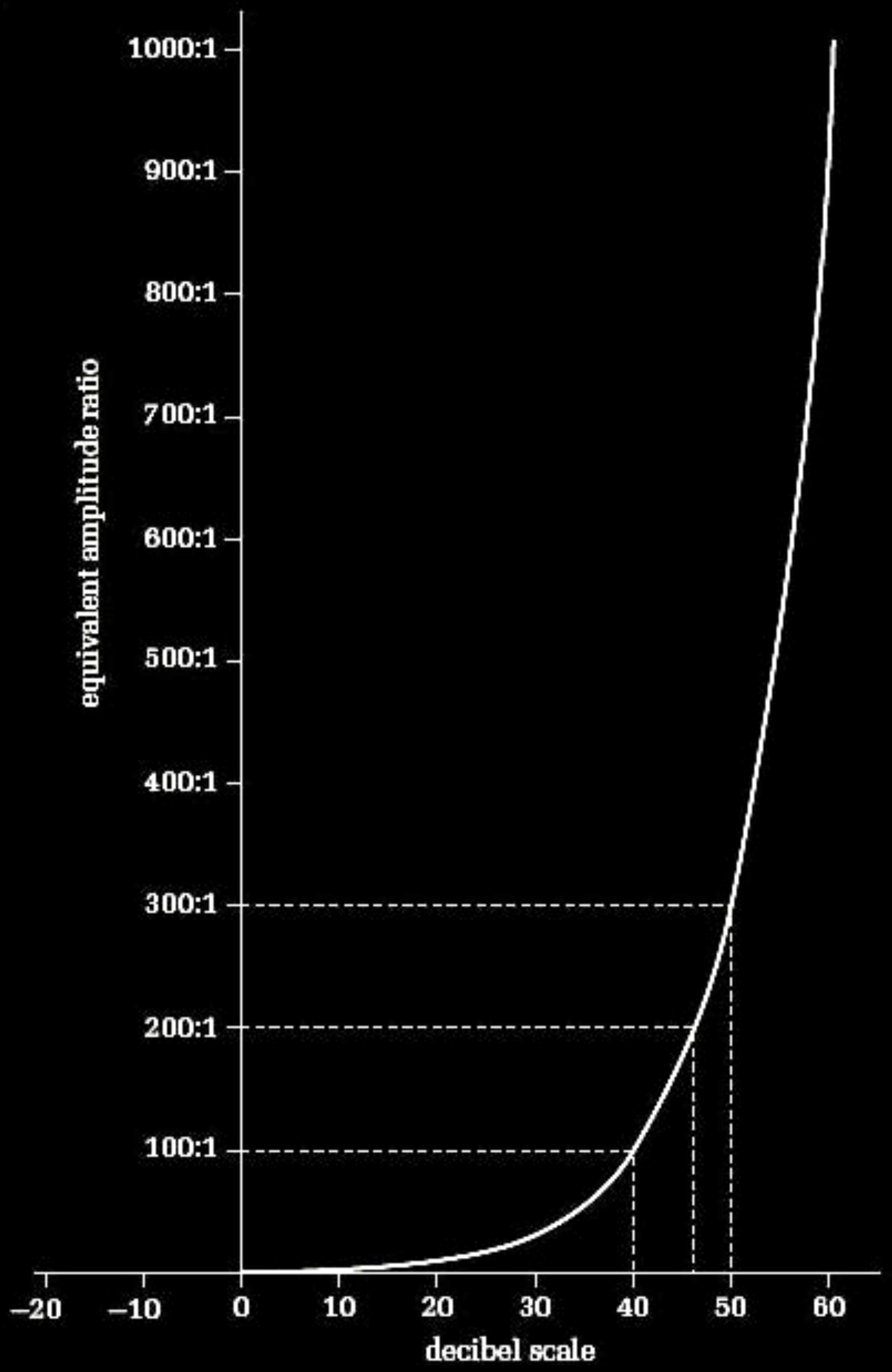
commonly measured in decibels (dB) - logarithmic units

Decibels

Decibels (dB) - logarithmic scale

Our perception of loudness is not linear, but exponential.

Logarithmic perception means that it takes more of a change in the amplitude to produce the same perceived change in loudness as the amplitude increases.



Amplitude

0 dB - silence

30 dB - whisper. all day long

60 dB - typical conversation. safe.

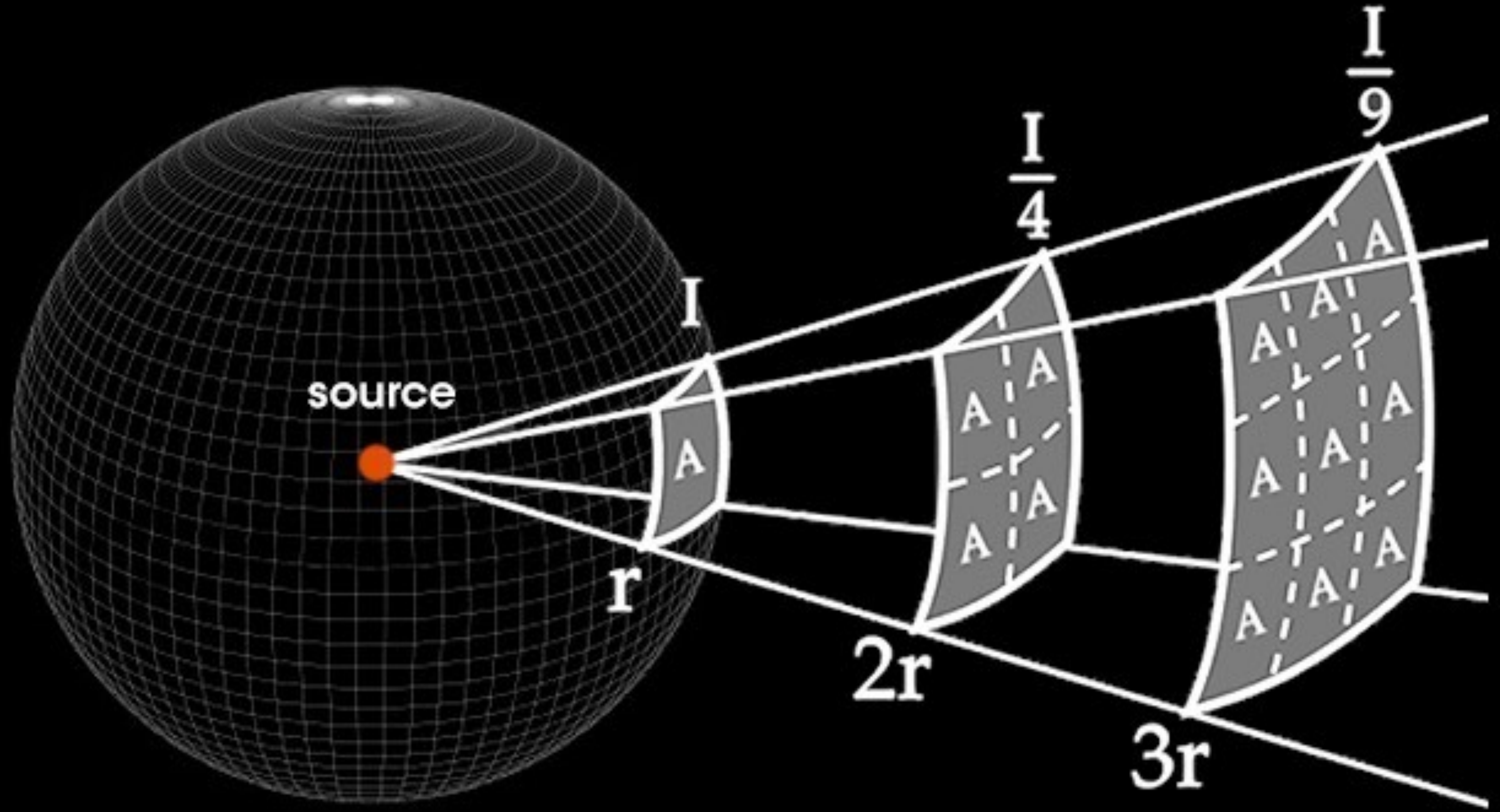
85 dB - bulldozer. permanent damage after 8 hours.

105 dB - headphones at max volume. chainsaw. hearing damage after 2 hours.

120 dB - the threshold of pain :(

Amplitude - inverse square law

sound intensity is inversely proportional to the square of the distance from the source

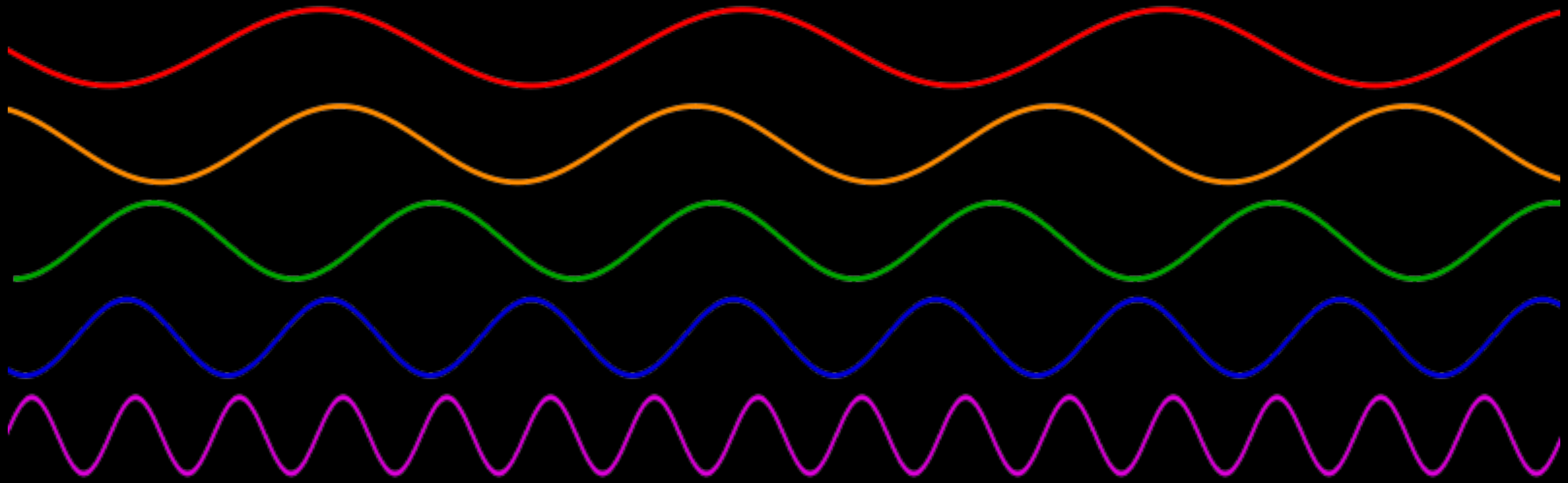


$$I \sim 1/r^2$$

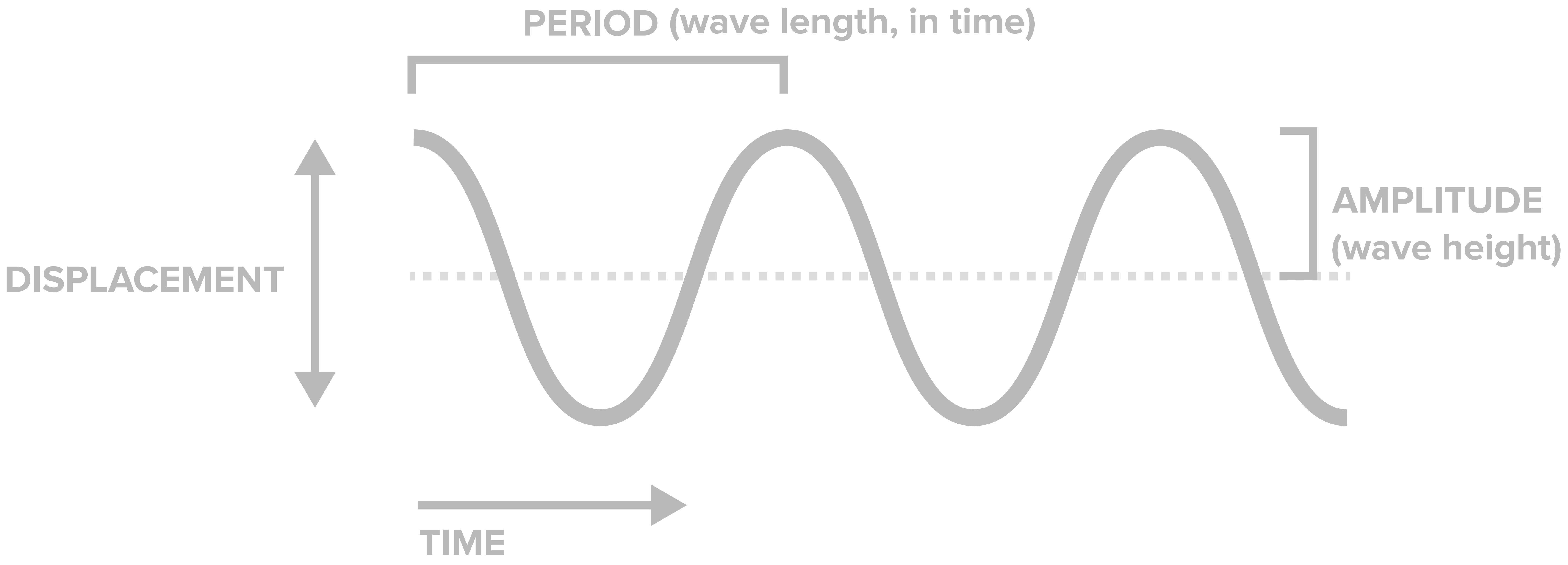
Frequency

rate at which the air pressure fluctuates is the frequency of the sound wave

Cycles per second, Hertz (Hz)

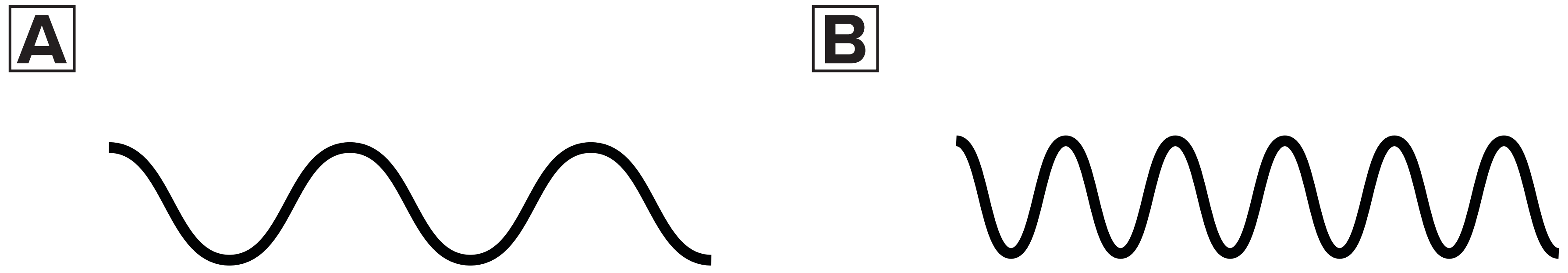


Period & Wavelength



FREQUENCY = **1/PERIOD** | the longer the **PERIOD**, the lower the **FREQUENCY***

FOCUS ON PERIOD



A has a longer PERIOD than B;
B has a higher frequency than A

Frequency	number of cycles per second (f)
Period	time it takes for one cycle to occur (T)
Wavelength	distance travelled in one cycle (λ)

frequency is inversely related to period

$$f = 1 / T \quad \text{or} \quad T = 1 / f$$

wavelength is equal to the speed of sound divided by the frequency

$$\lambda = v / f$$

v = the speed of sound is constant, ~1,125 feet per second (one mile in 5 seconds)

Frequency Limbo

How high can you go?

LISTEN: Hearing range 20 Hz to 20,000 Hz (0-20Hz frequencies are infrasonic)

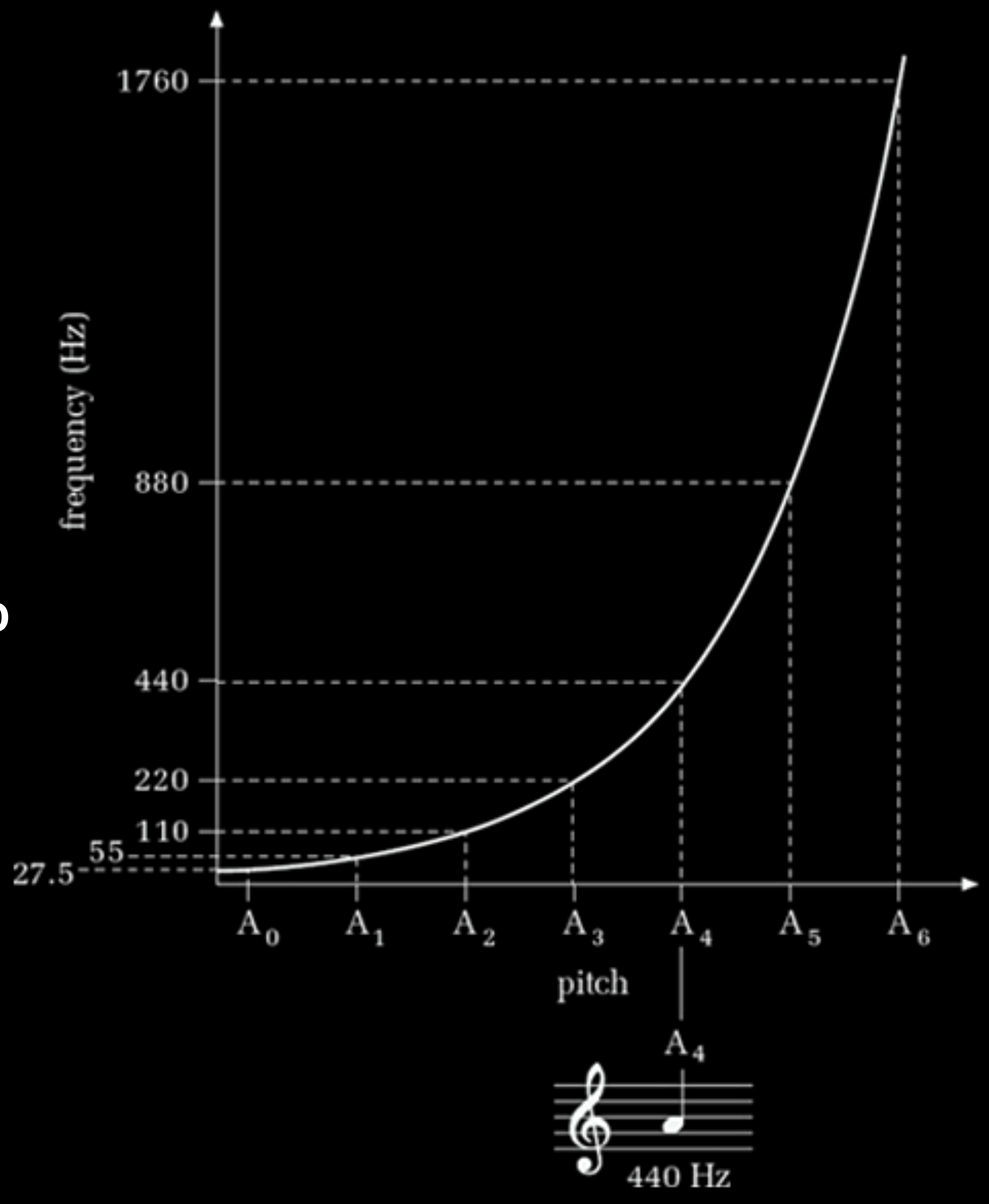
Frequency Ranges (fundamental)

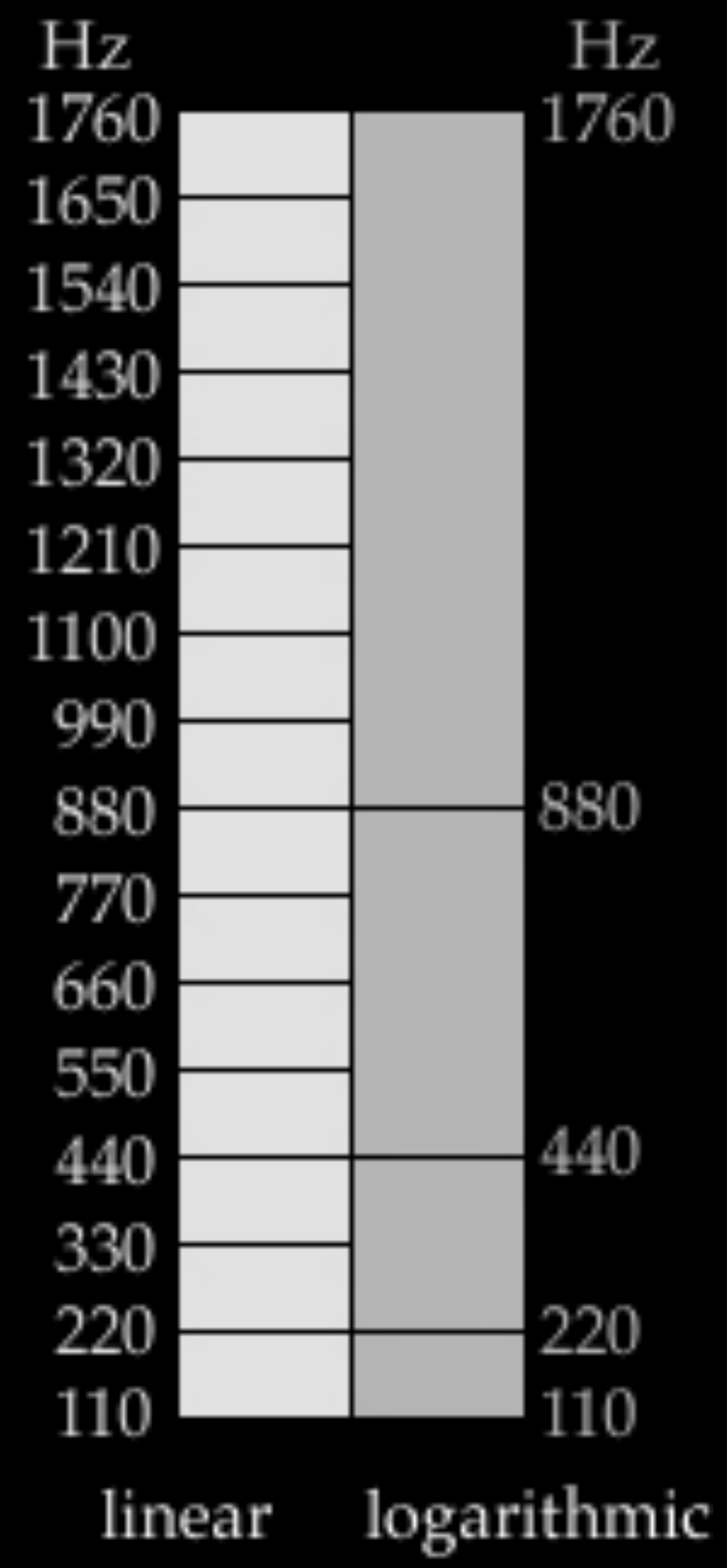
	Low (Hz)	High (Hz)
Piano	27.5	4186
Speech	80	500
Standard Digital Audio	0	22,050
Human hearing	20	20,000
Dog hearing	20	45,000
Seal hearing	1000	123,000

Frequency & Pitch

We experience pitch logarithmically as well

Octave - 2:1 frequency ratio





Frequency

The interval between two notes can be measured by the ratio of their frequencies.

(just intonation)

1:1 (unison)

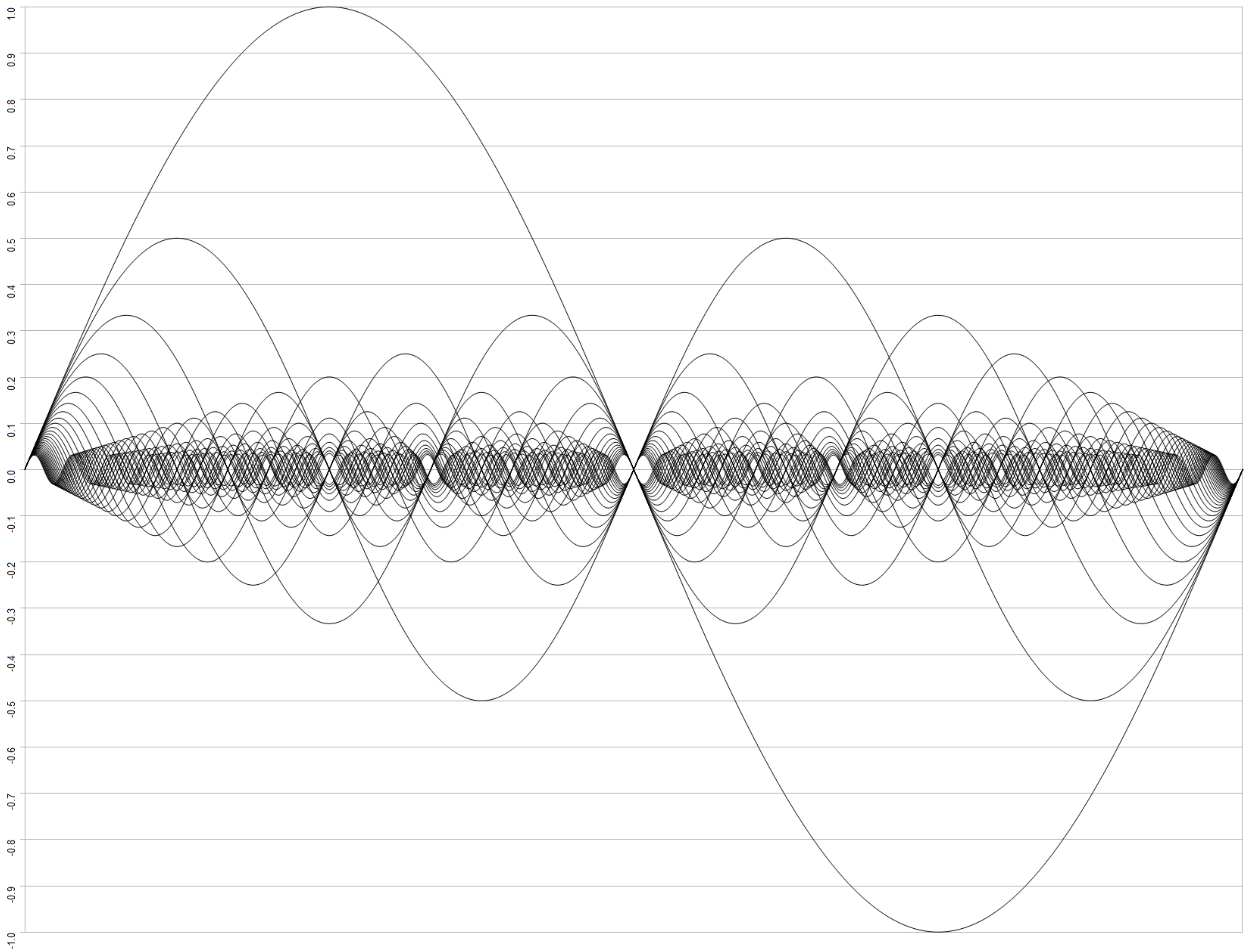
2:1 (octave)

3:2 (perfect fifth)

4:3 (perfect fourth)

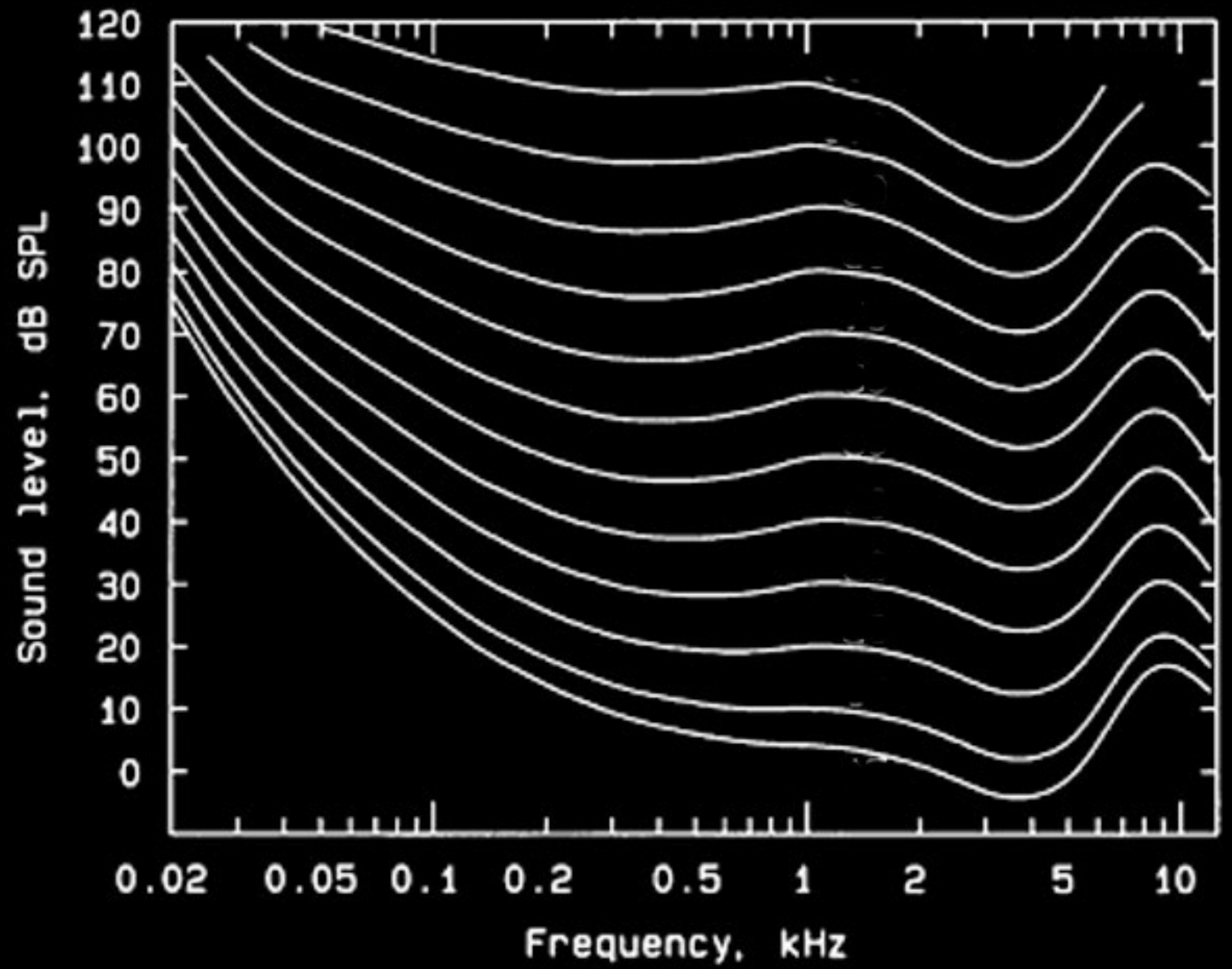
5:4 (major third)

6:5 (minor third)

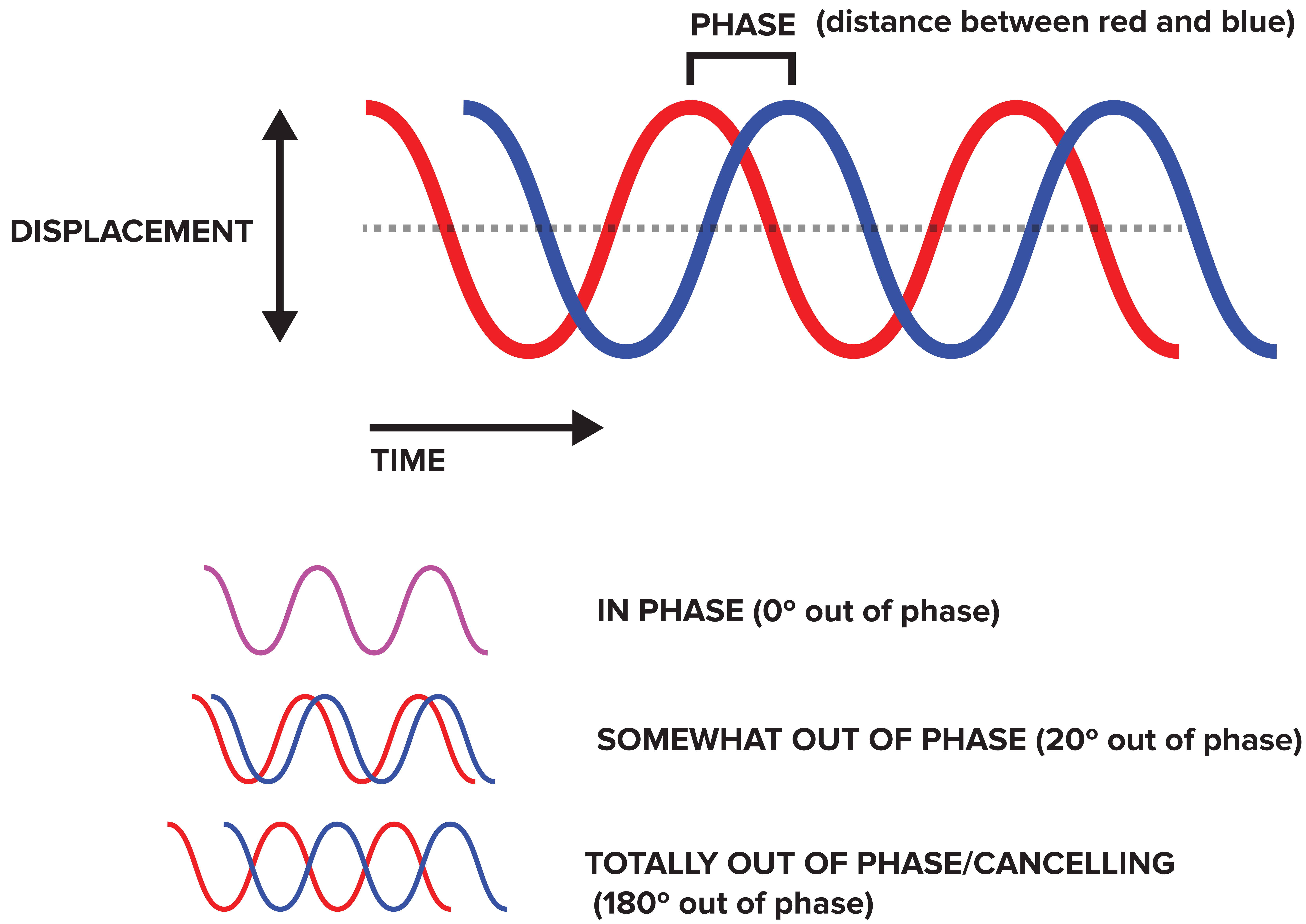

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0

Equal Loudness Contours

(Fletcher-Munson Curves)



Physical (Acoustics)	Perceptual (psychoacoustics)	Units
amplitude	loudness	decibels (dB)
frequency	pitch	hertz (Hz)
duration	time	seconds (s)
timbre	quality / tone / spectral content	


PHASE (distance between red and blue)
DISPLACEMENT
TIME
IN PHASE (0° out of phase)
SOMEWHAT OUT OF PHASE (20° out of phase)
TOTALLY OUT OF PHASE/CANCELLING
(180° out of phase)

2/24 Sound Terminology Review, Acoustics | SLIDES

HW: Read Introduction to Acoustics: Waves and Sound (disregard the mathematics!)

Watch this short video on how the ear works (disregard technical names, just understand the system as a whole)

Listen to "Dripsody" by Hugh LeCaine and "One Minute" by Ryoji Ikeda

How do these pieces activate the ears? What techniques does it seem were used to create these sounds (microphones, computer, instruments, etc.)? How is the work organized; how does it change over time (or how is it structured)?