Chapter two

Sound

Studying Sound

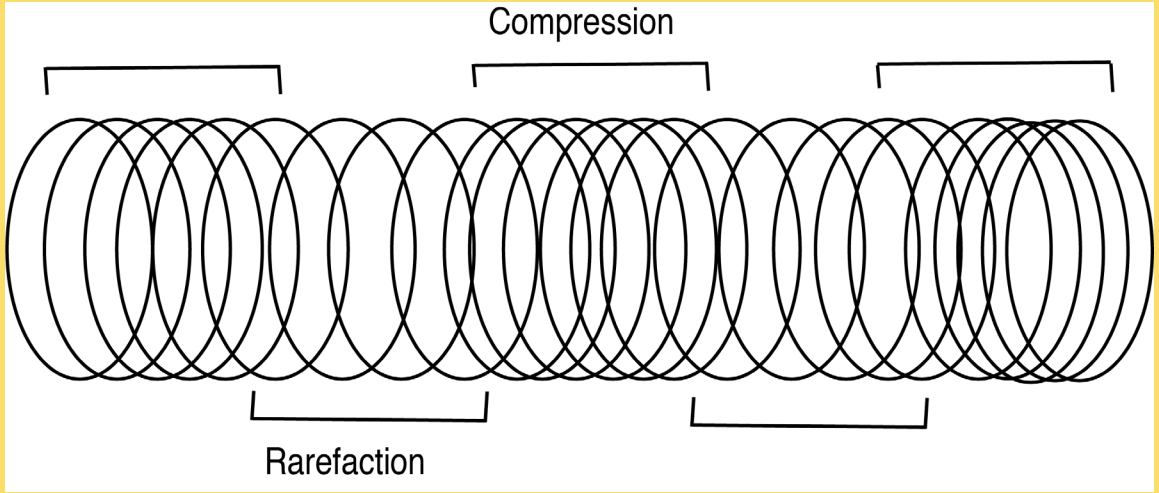
Outline

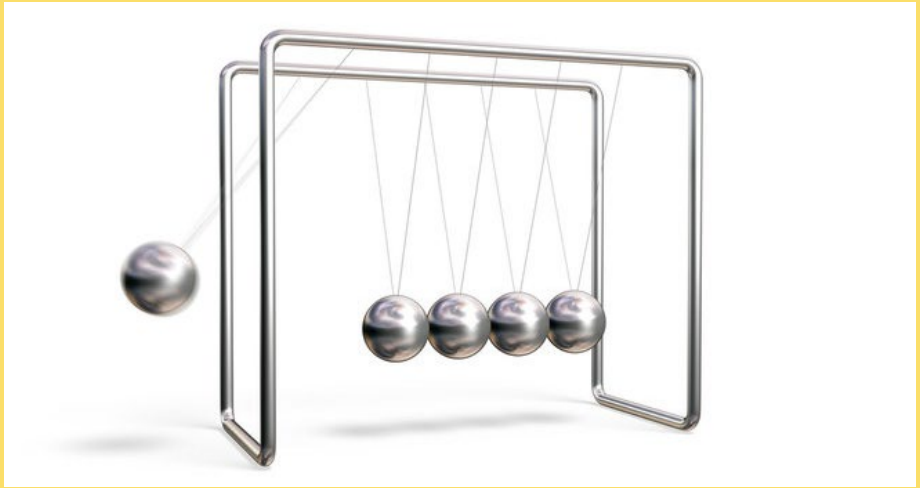
Sound Waves
Frequency
Consonance and Dissonance
Amplitude
Timbre
Wave Interference
Envelopes
Smearing, Rhythm and Masking
Sound Libraries & Copyright
Digital Sounds

Longitudinal Waves

Compression and rarefaction

Wavelength: one compression and one rarefaction





Livescience.com: Newton's Cradle

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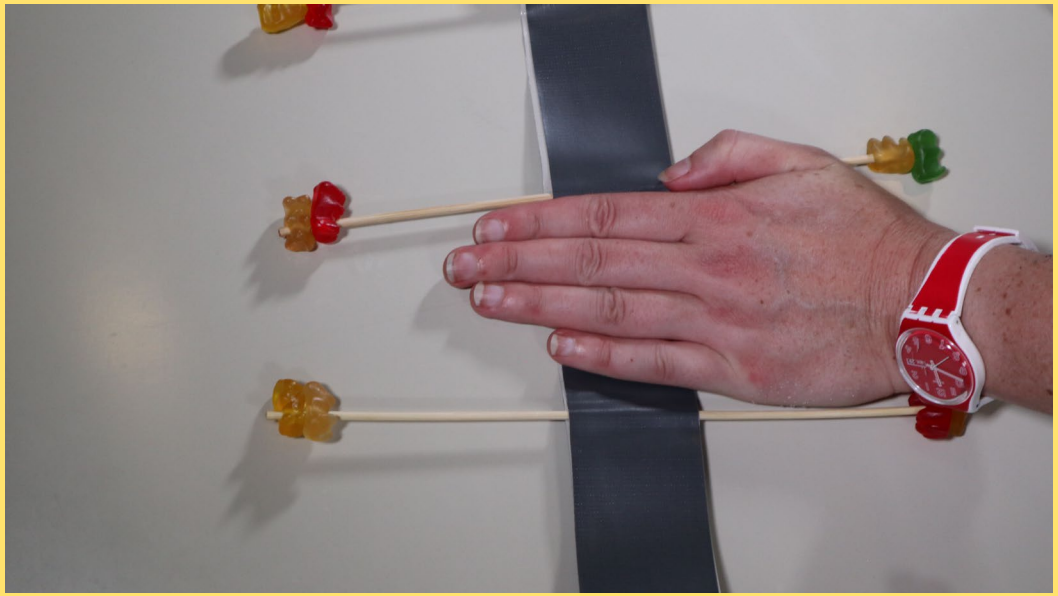
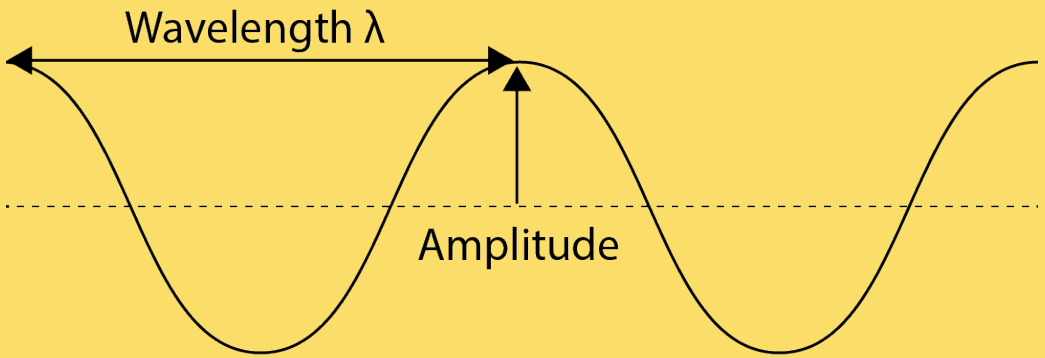
Transverse Wave model

Higher wave: more power = more amplitude

Faster wave = more frequent = higher frequency





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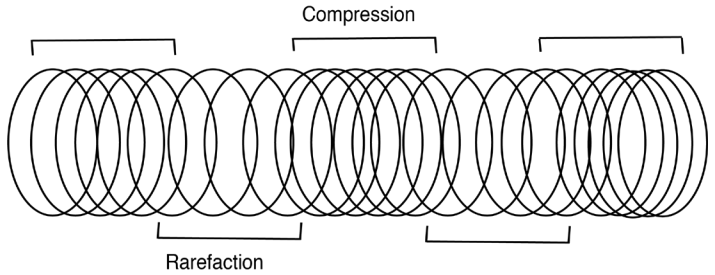
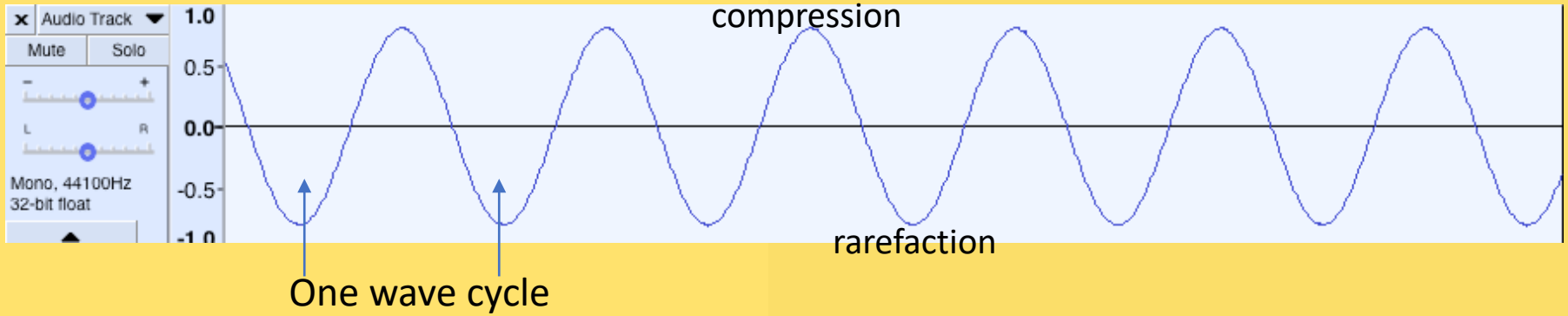
Sound Wave in Audacity

`Generate > Tone > OK`





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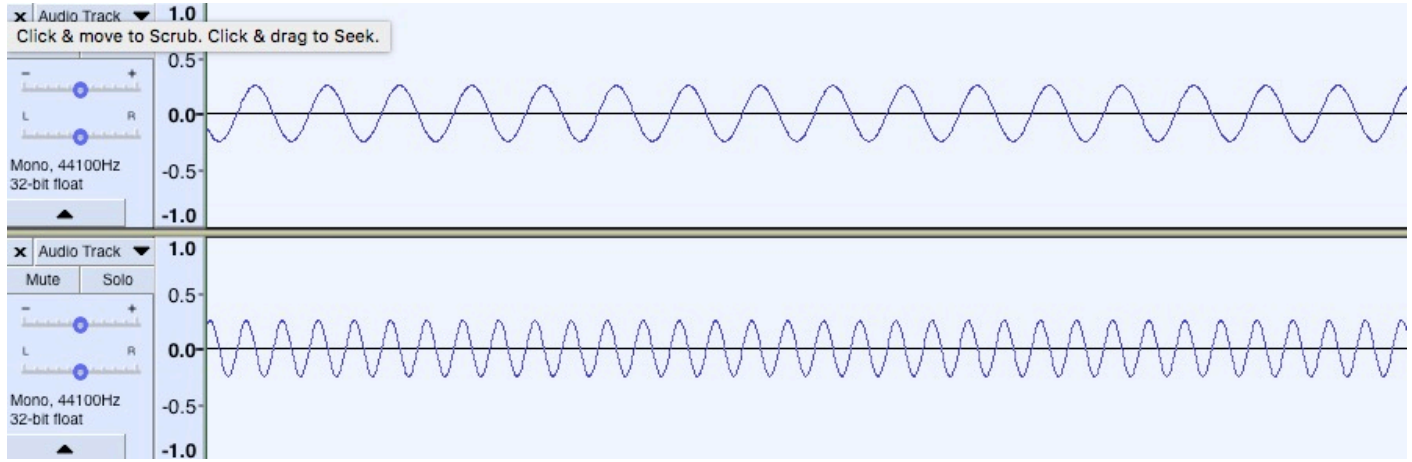
Frequency

Cycles per second = Hertz (Hz)

1000 Hz = 1 KHz

1 million Hz = 1 MHz



440 Hz and 880 Hz

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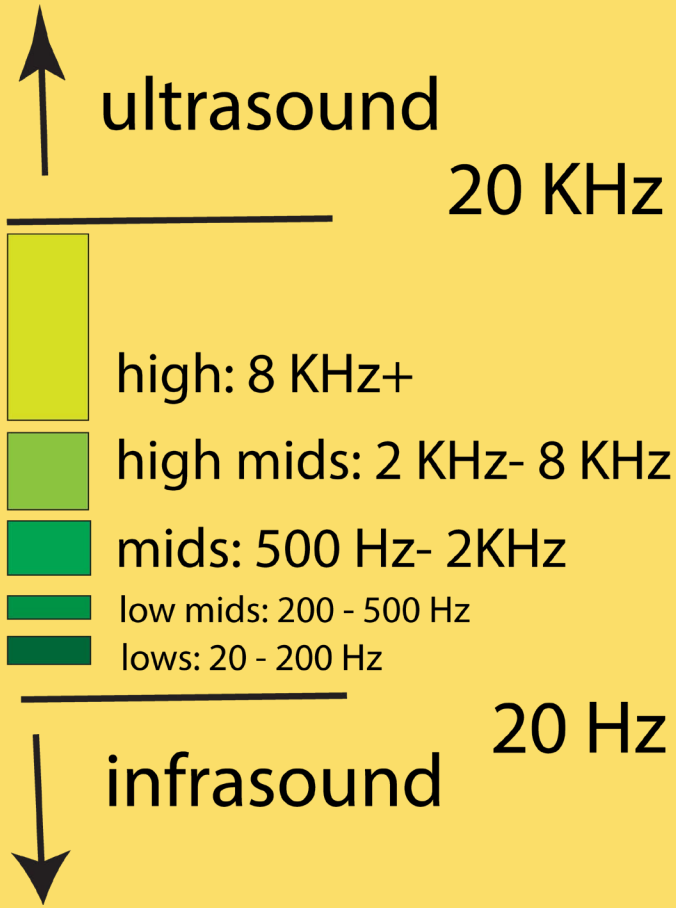
Refresher: Human Hearing and Frequency

Human hearing: 20 Hz to 20 KHz

Most in **mids**



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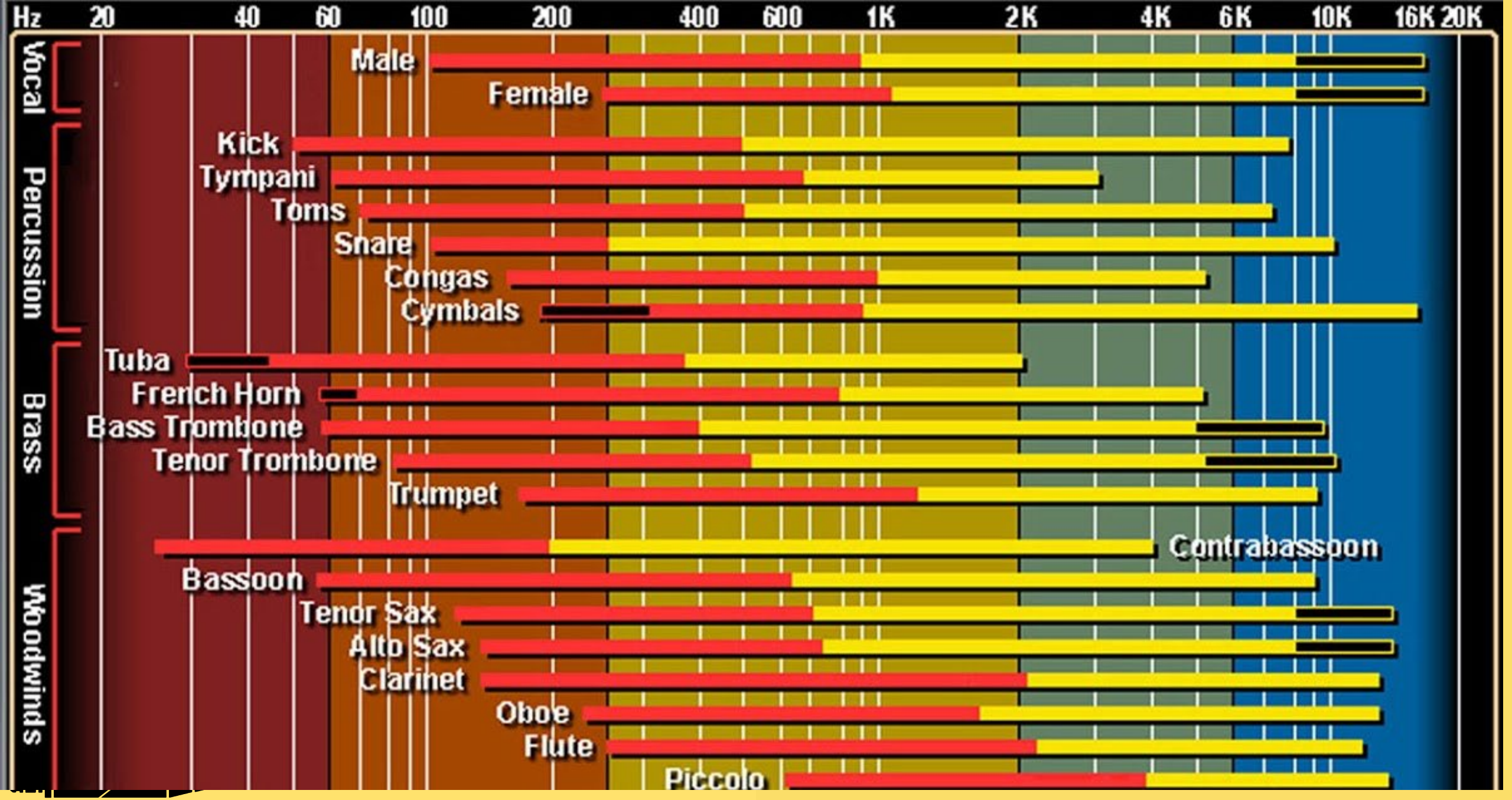
Musical Instrument Frequencies

Instrument	Frequency Range
Piano	28 Hz to 4186 Hz
Trombone	82 Hz to 493 Hz
Kick Drum	60 Hz – 150 Hz
Snare drum	100 Hz- 6 KHz
Soprano singer	262 Hz to 1050 Hz
Tenor singer	240 Hz to 525 Hz
Bass Singer	87 Hz to 330 Hz



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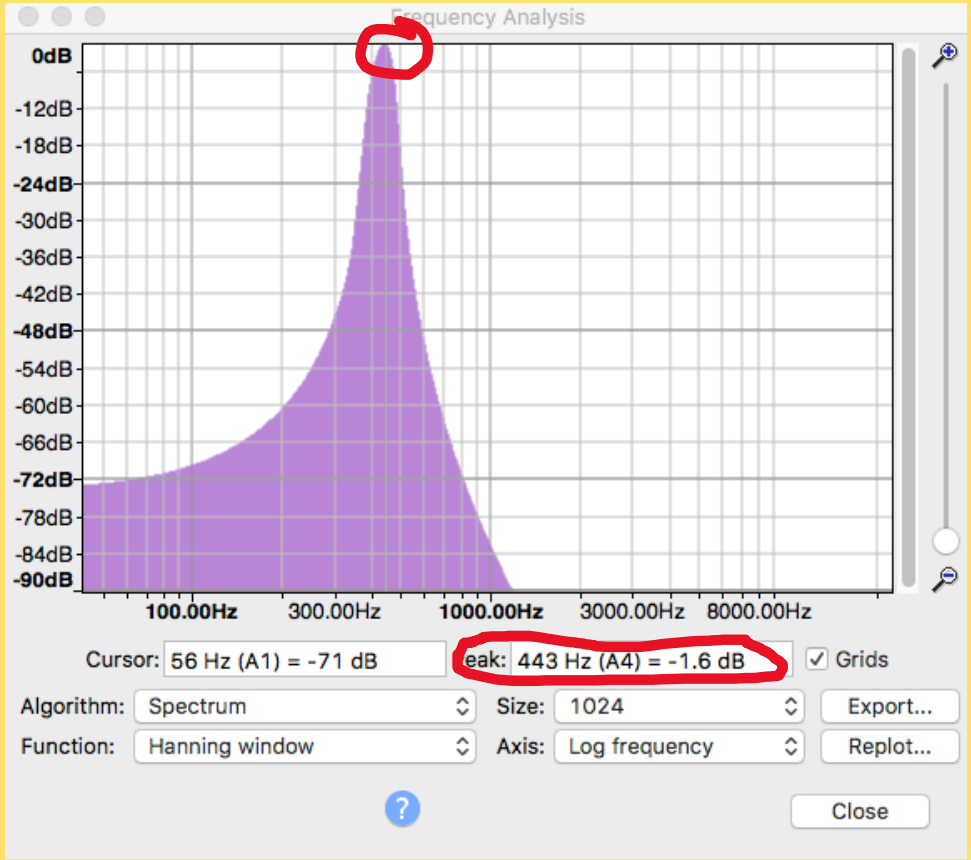
http://homerecordingweekly.blogspot.com/2010/09/eq-for-mixing-purposes.html

Spectral Analysis



Analyze: Plot Spectrum

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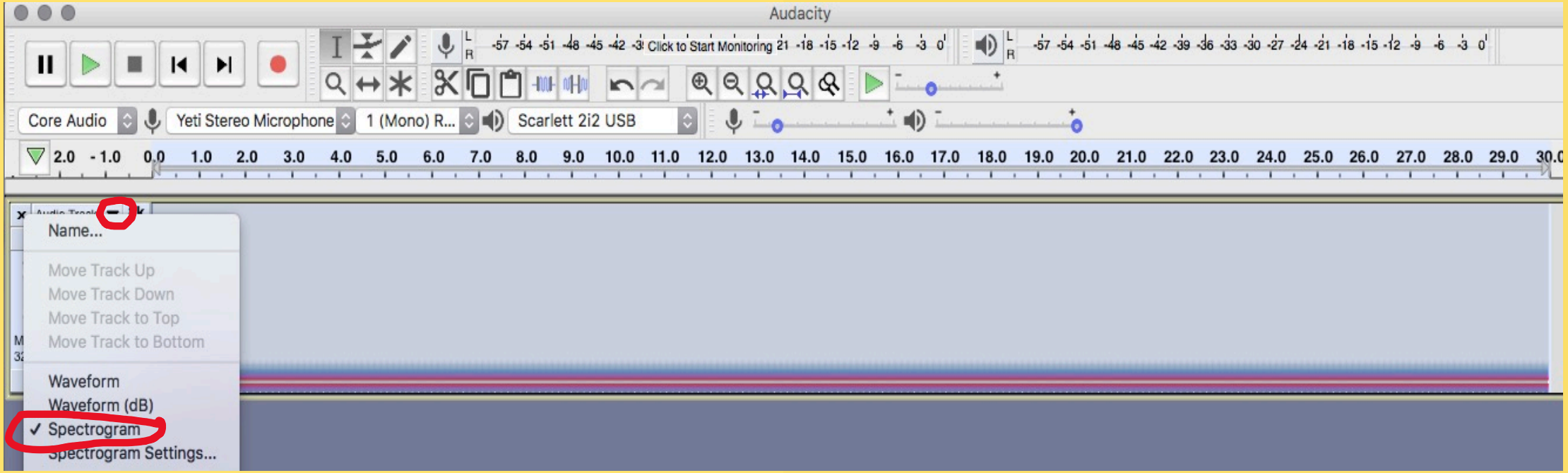
Spectrogram view



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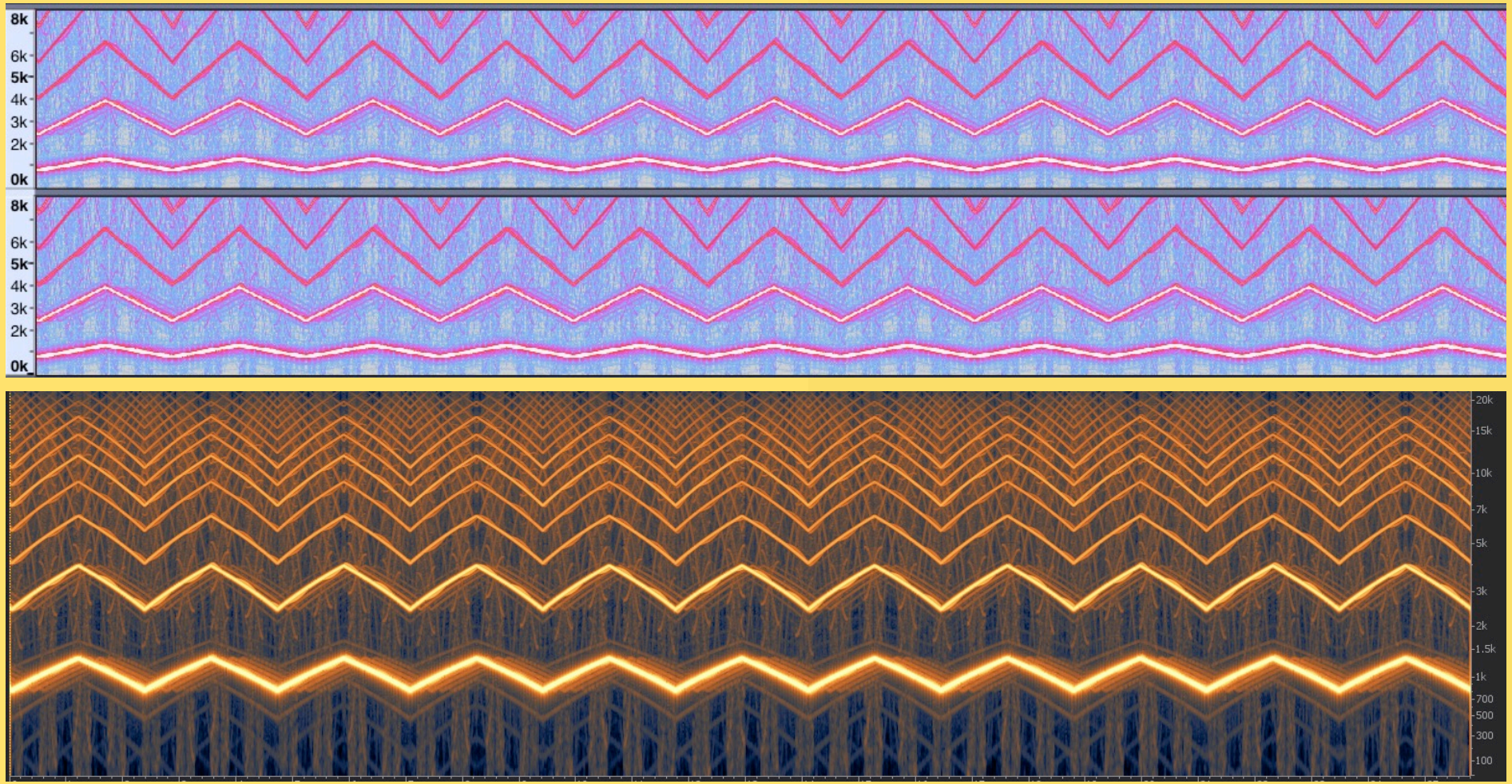
Siren in Audacity and RX



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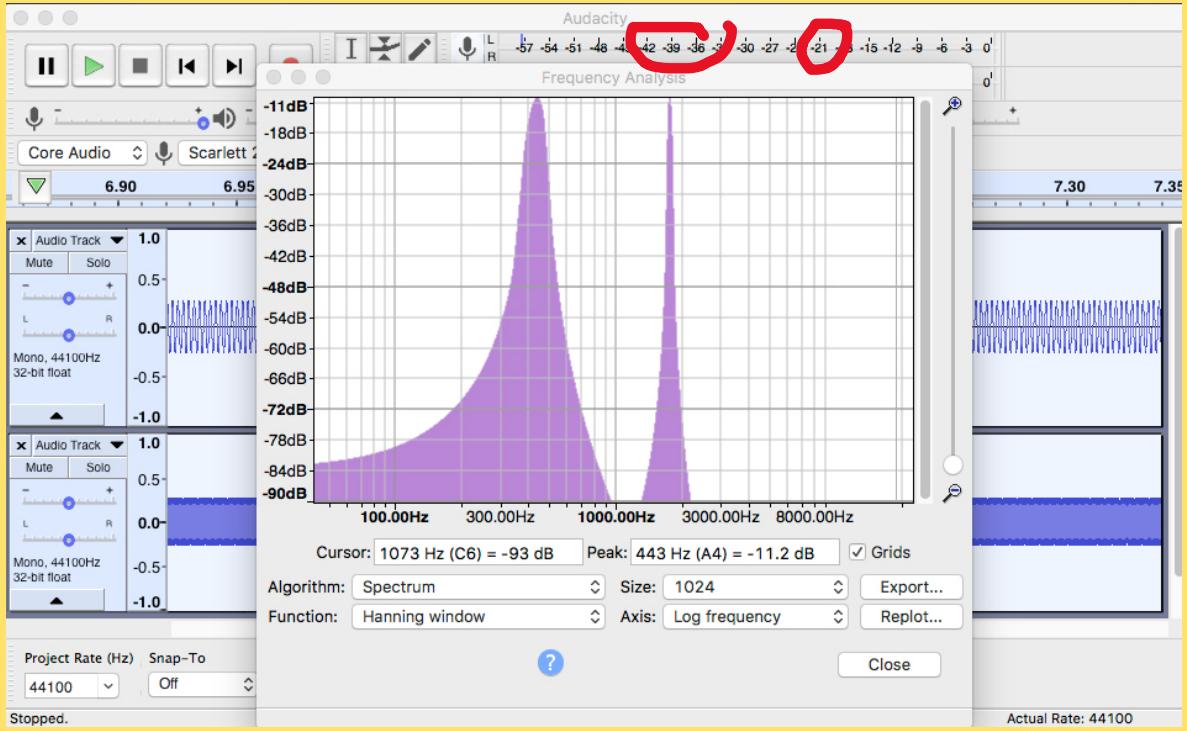
Plot Spectrum: 2 tones



Generate > Tone > 440 Hz

Tracks > Add New > Mono Track

Generate > Tone > 1760 Hz

Analyze > Plot Spectrum

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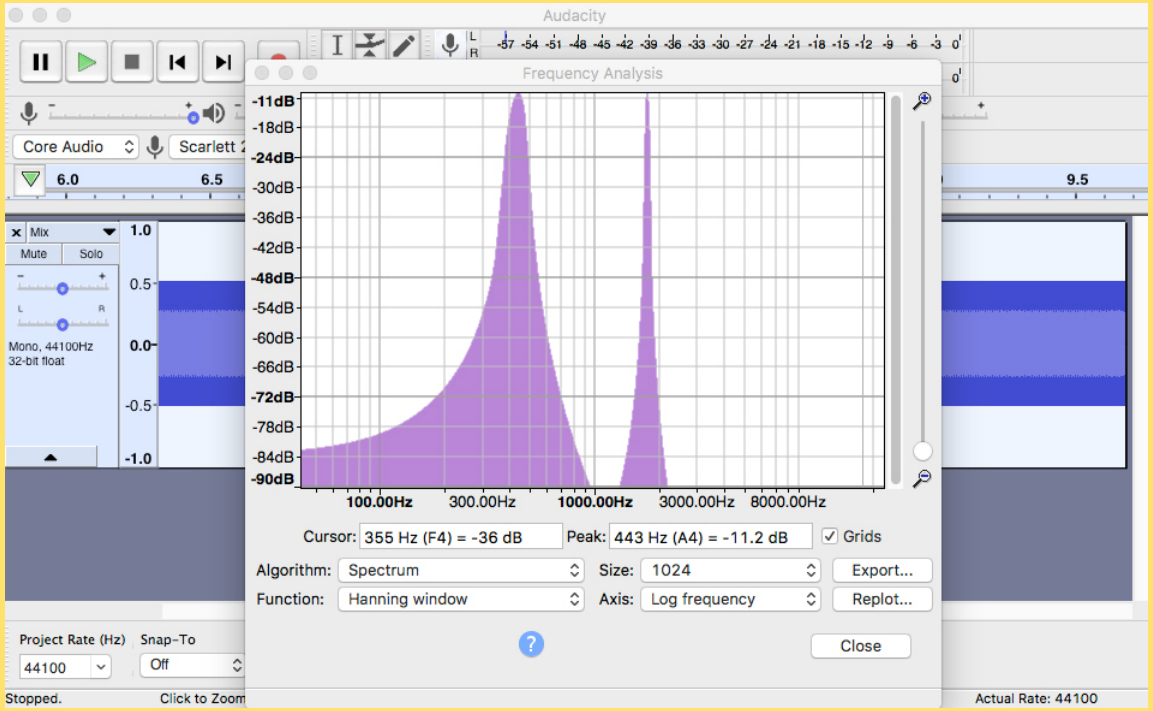
Mixing Frequencies



`Effect > Amplify > reduce by 6 dB`

`Tracks> Mix and Render`

`Analyze > Plot Spectrum`

Undo (`Cmd/Ctrl Z`). Delete track 2.
`Generate > Tone > 1700 Hz.`

Studying Sound

Consonance and Dissonance

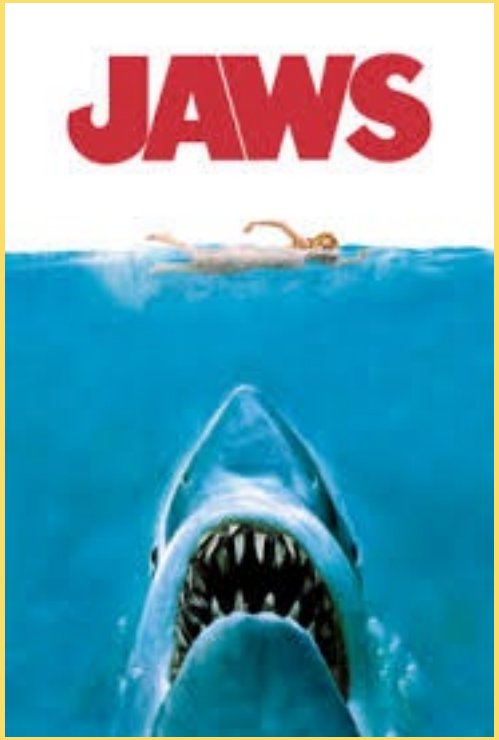
Generate > Tone > 440 Hz (A4)

Tracks > Add New > Mono Track

Generate> Tone > 466.16 Hz (A#4)

Tracks > Add New > Mono Track

Generate > Tone > 523.25 (C5)



John Williams, Jaws theme

https://www.youtube.com/watch?v=ZvCI-gNK_y4

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Diabolus in Musica

Frans Francken (1581- 1642), *Death Playing the Violin.* [*Wikimedia Commons*]

"The Unsettling Sound of Tritones, The Devil's Interval"

NPR, All Things Considered
October 31, 2017

https://www.npr.org/2017/10/31/560843189/the-unsettling-sound-of-tritones-the-devils-interval

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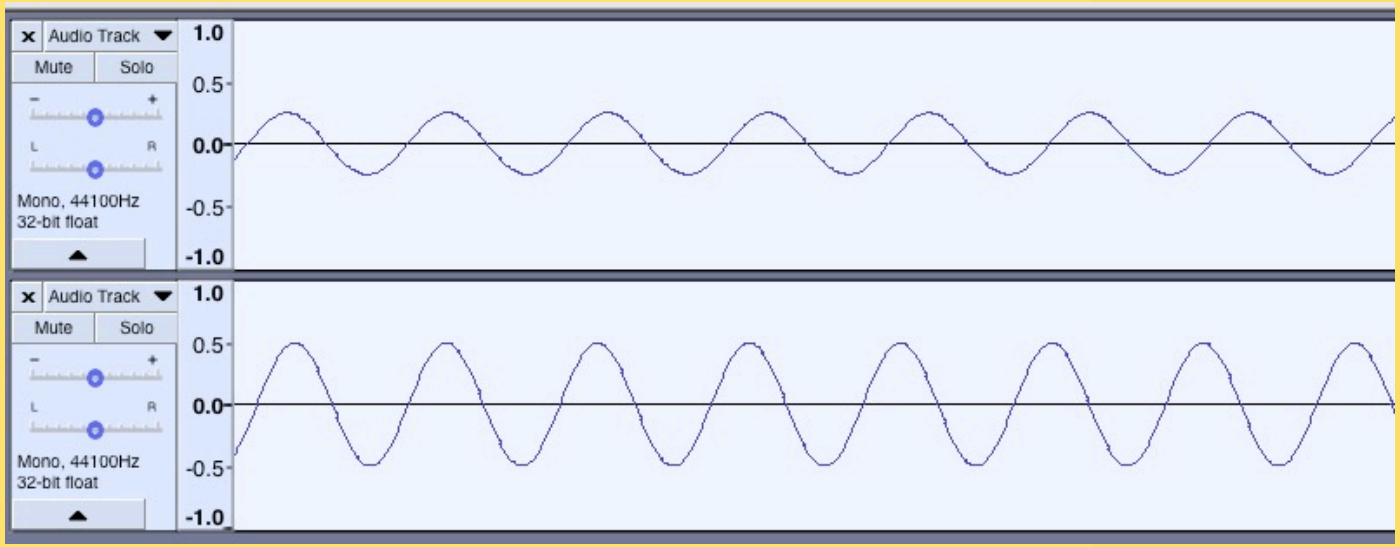
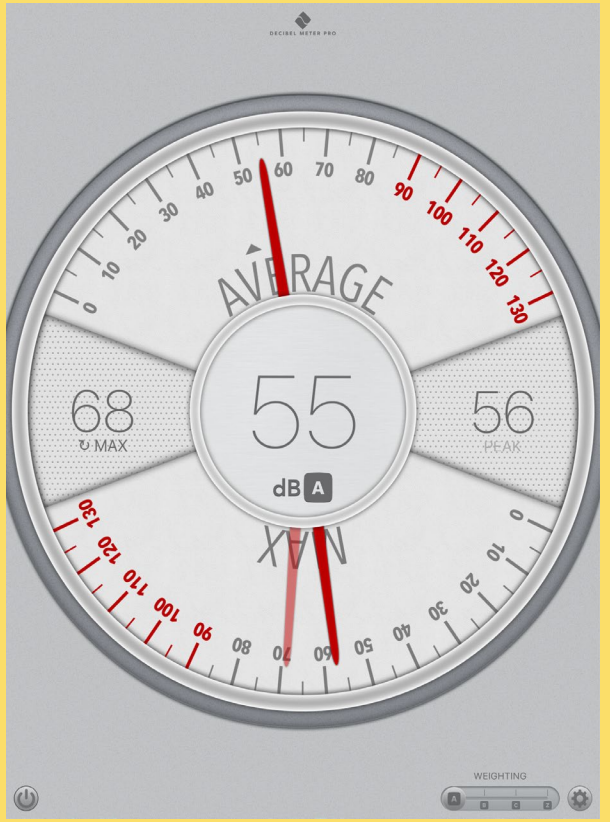
Amplitude

Height of wave

Pascals and Decibels (dB)

`Effects> Amplify > +6 dB`





Decibel Meter Pro, showing the current sound is 55 dBA

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Amplitude And Hearing Refresher

Loudest Sounds:

Krakatoa 180 dB

Blue Whale 200 dB

Pistol Shrimp 200 dB

Earthquakes 250 dB

Tunguska Meteor 300 dB

dB Level	Examples	Permitted Exposure (Hours per Day)
10	Breathing	
20	Whisper	
30	Library	
50	Quiet Office	
60	Conversational Speech, Electric shaver	
65	Piano Practice	
70	Noisy Restaurant	
75	Alarm Clock	
80	Vacuum Cleaner	
85	Garbage Disposal / Busy Hotel Lobby	
90	Tractor / Subway	8
100	Blender, Factory Noise	2
105	Motorcycle, Orchestra	1
110	Power Saw, Heavy Truck, Power Mower	0.5
115	Uncomfortable Feeling Starts	0.25
120	Disco / Loud Bar Music / Shotgun	0
130	Cymbal Crash, Air Raid Siren	0
140	Rock Concert Front Row / Jet	0
150	Chest begins to vibrate	0
160	Eardrum bursts	0
190	Loudest Possible Sound	0

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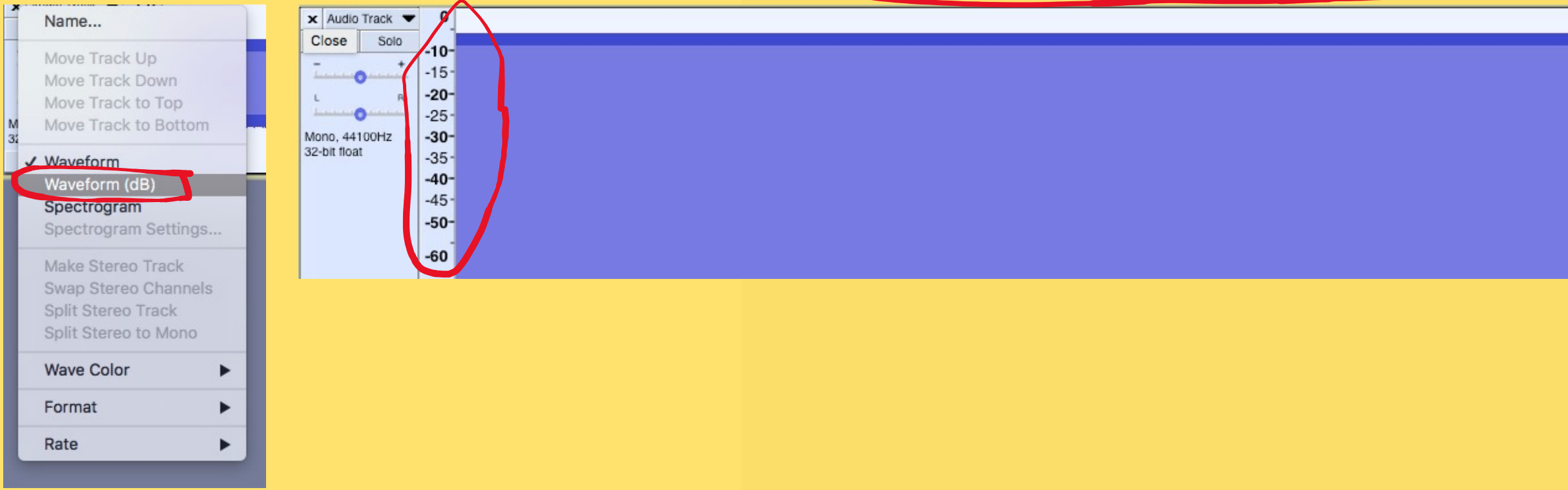
Digital Decibels…. dBFS



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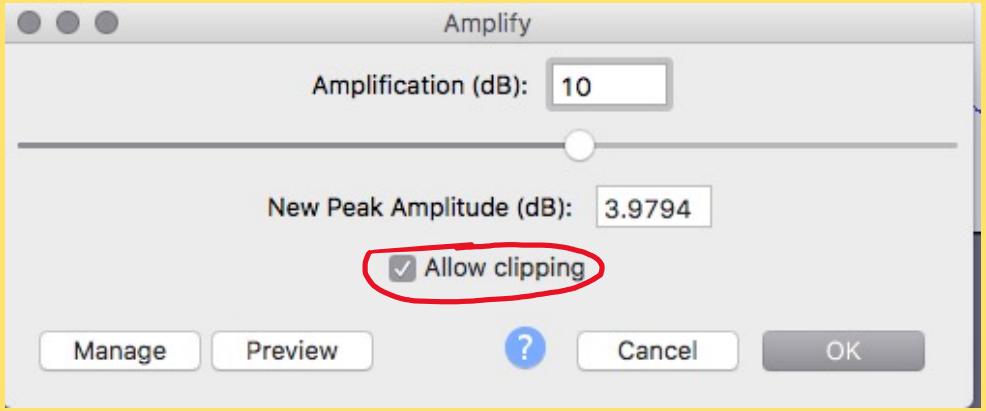
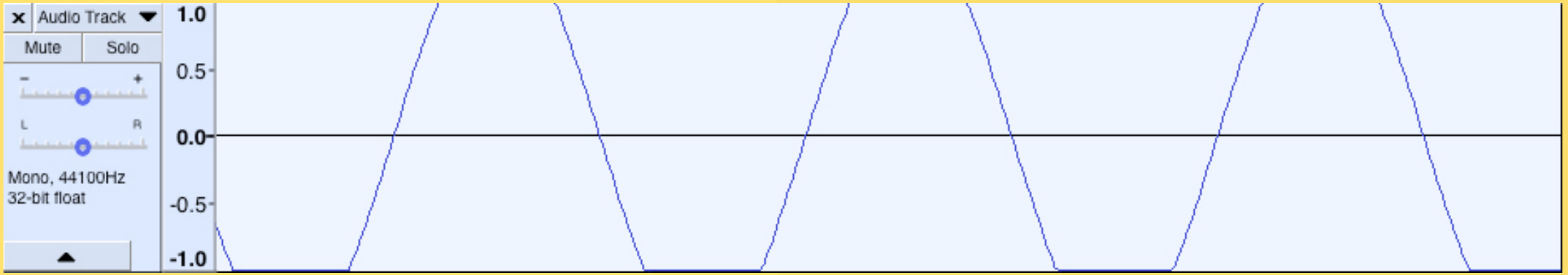
CLIPPING



Effect> Amplify > + 10 dB, Allow Clipping



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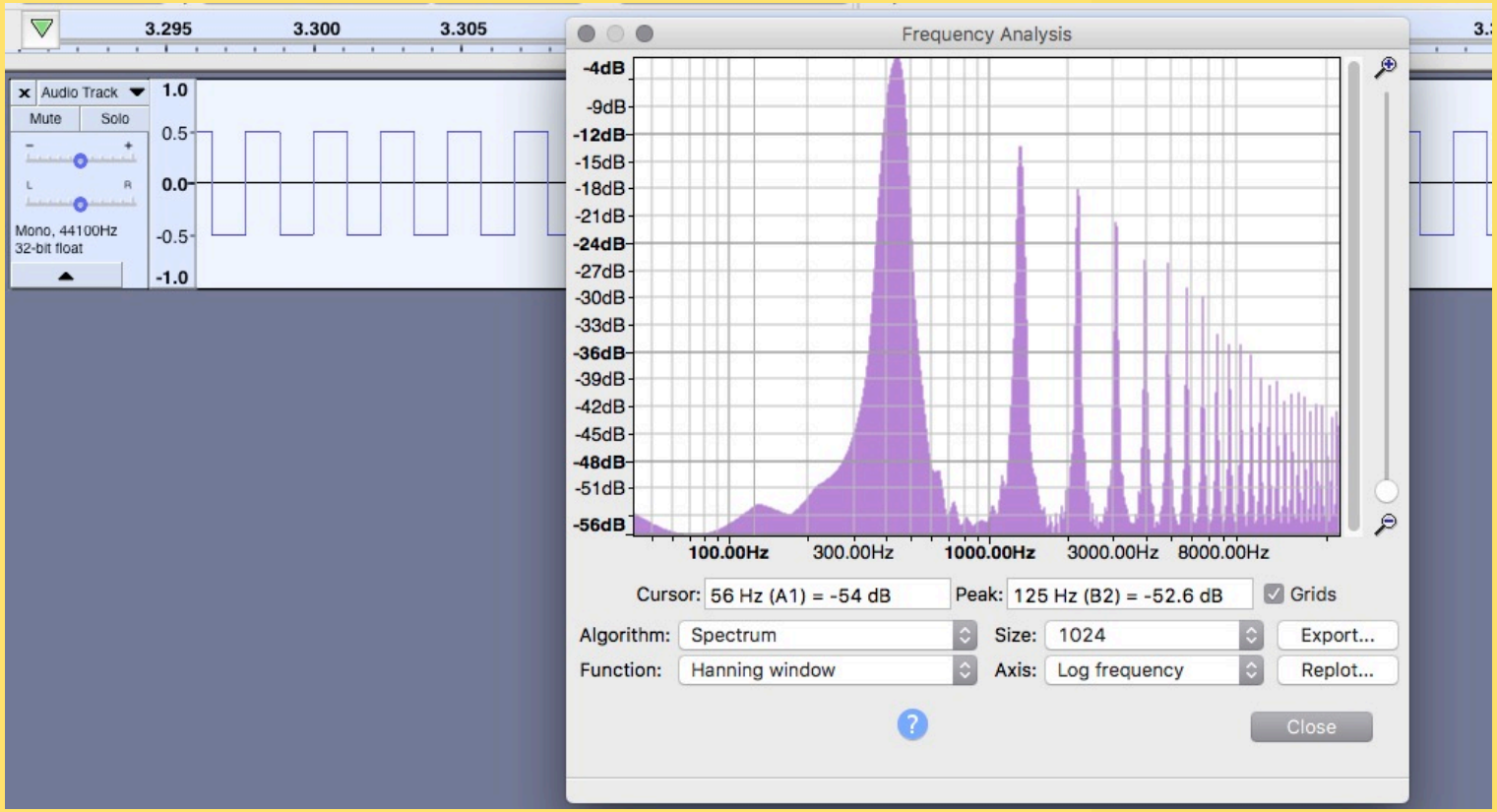
TIMBRE: HARMONICS



Generate>
Tone > Square wave

Analyze >
Plot Spectrum

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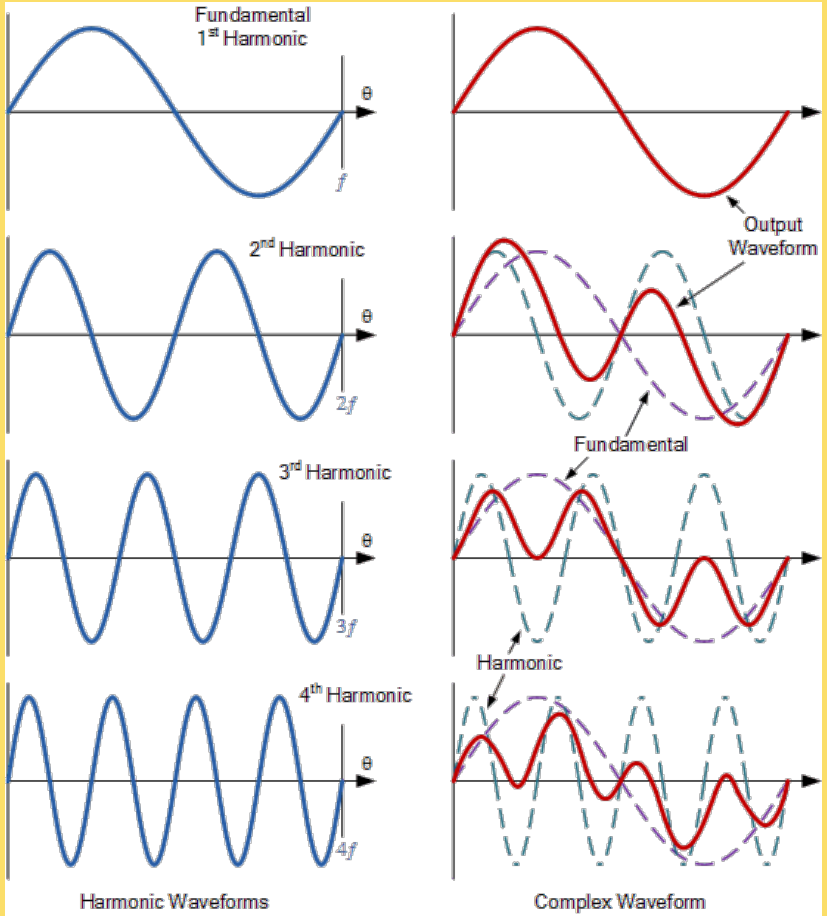
Harmonics

- Odd or Even
- Ratio of Fundamental



https://www.electronics-tutorials.ws/accircuits/harmonics.html

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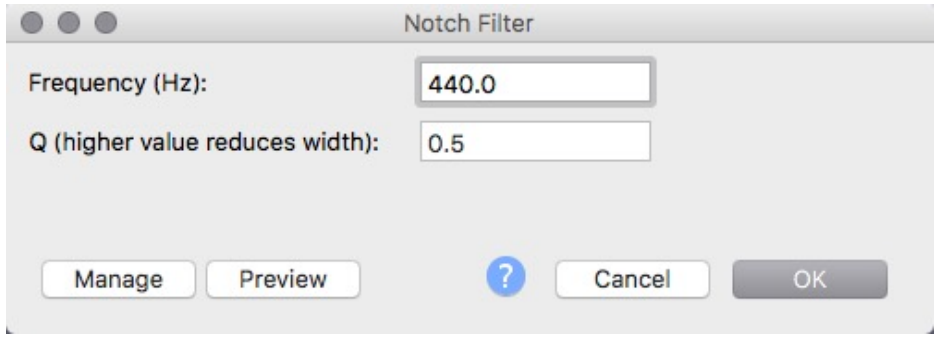
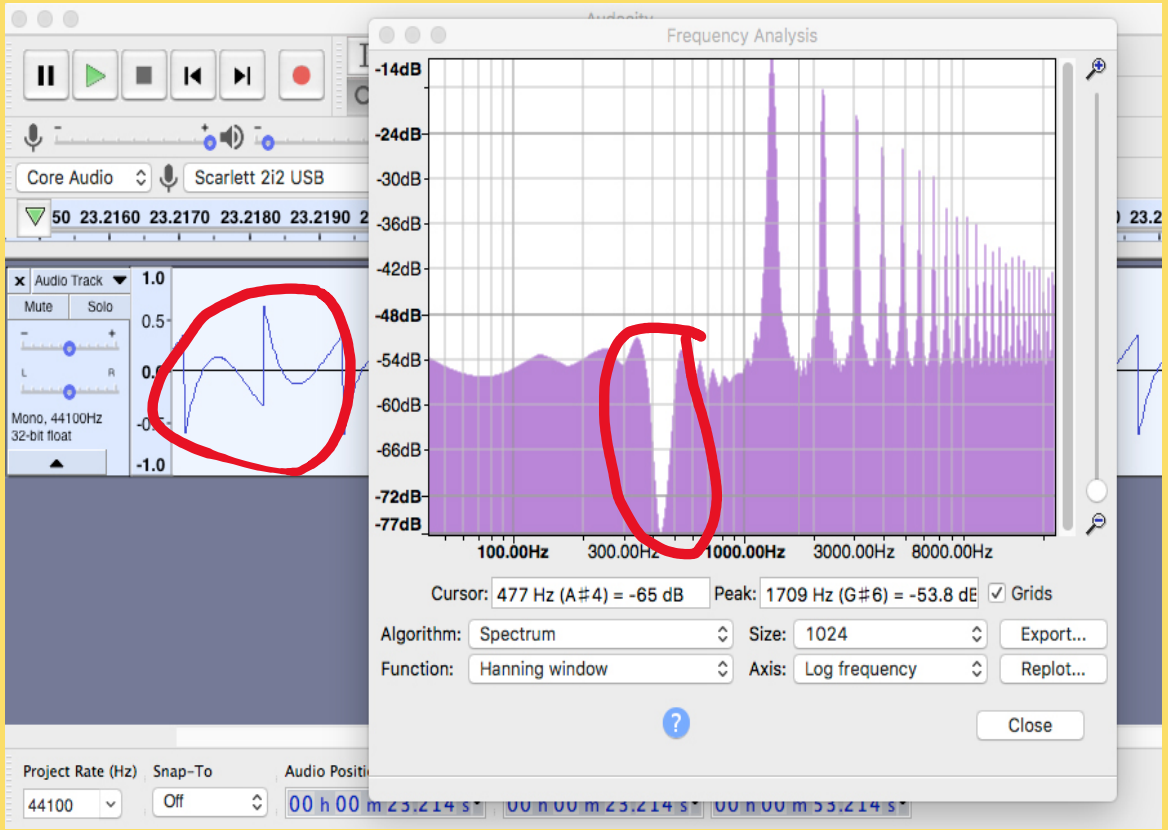
Phantom Frequencies

Generate > tone > square > 440 Hz

Effect > Notch Filter > 440 Hz





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Combination Tones

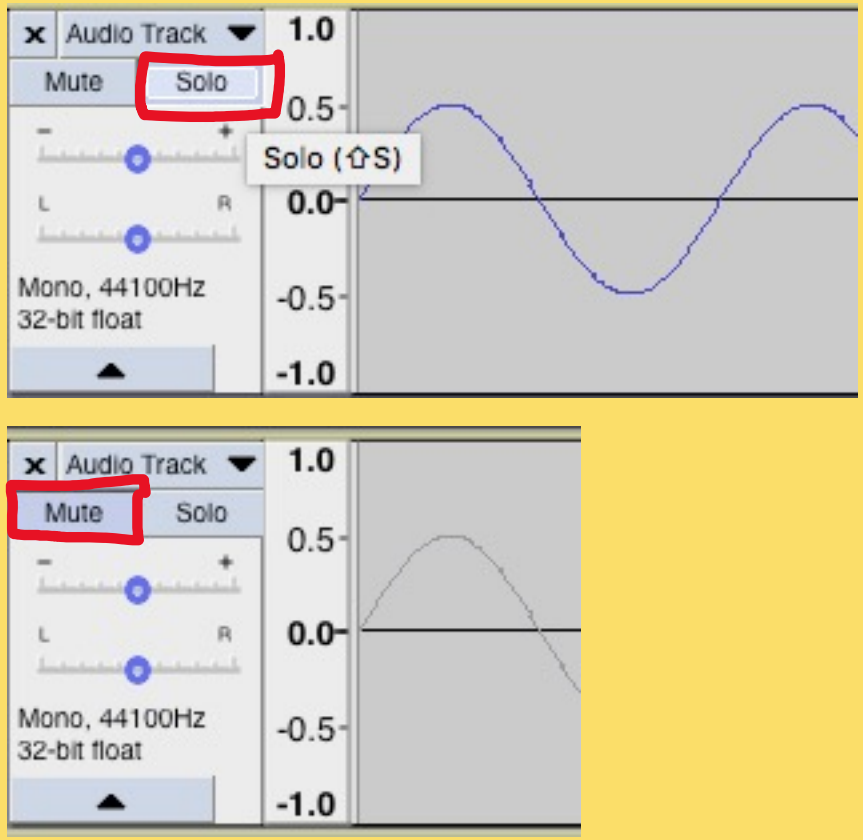
Difference Tones:

(Sine wave)

Generate >Tone > 300 Hz

Generate > Tone > 1000 Hz

Generate > Tone > 1300 Hz



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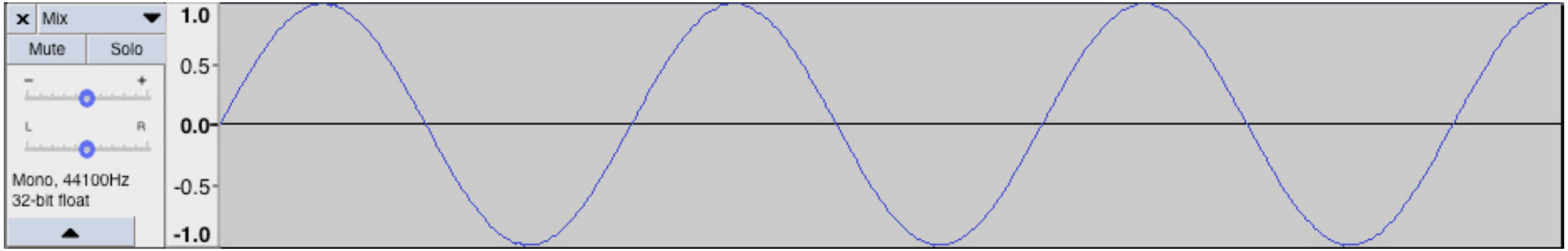
WAVE INTERFERENCE: Constructive

Generate > Tone > Sine wave at 0.5

Generate > Tone > Sine wave at 0.5

Tracks > Mix > Mix and Render



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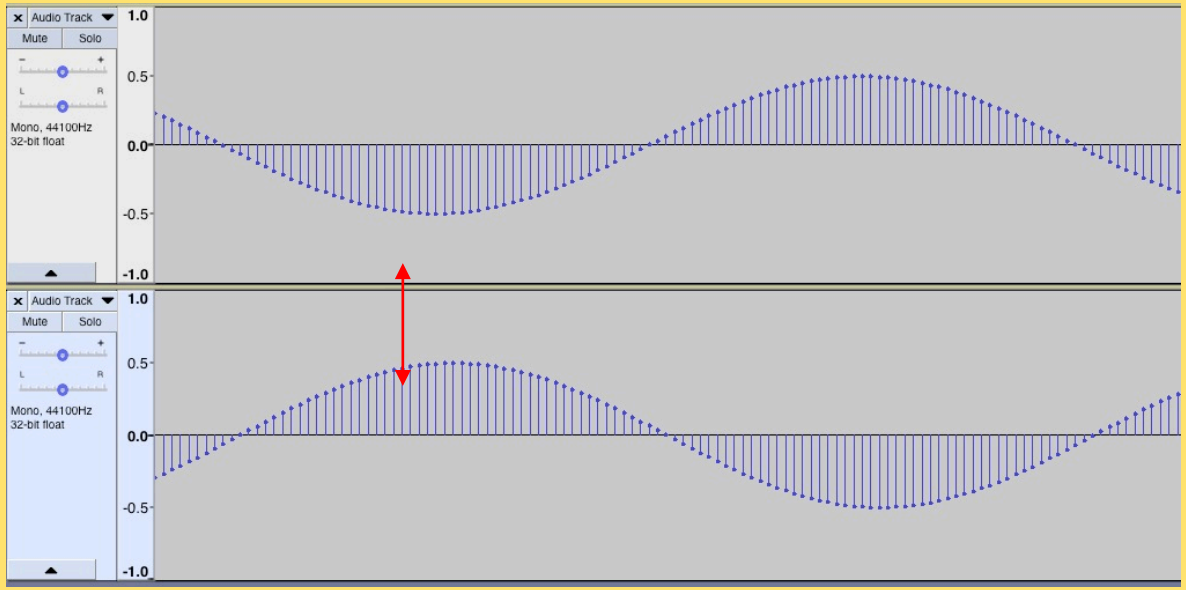
WAVE INTERFERENCE: Destructive

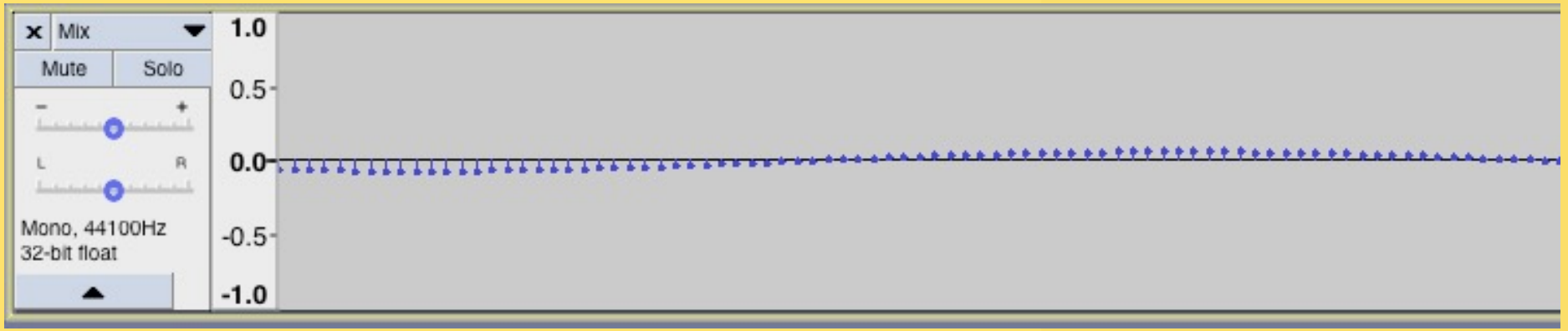


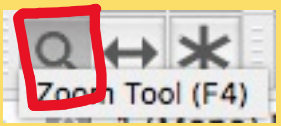
Generate > Tone > Sine wave at 0.5

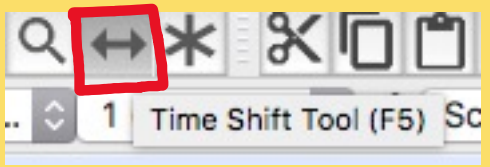
Generate > Tone > Sine wave at 0.5

Shift second track ½ cycle

Tracks > Mix > Mix and Render







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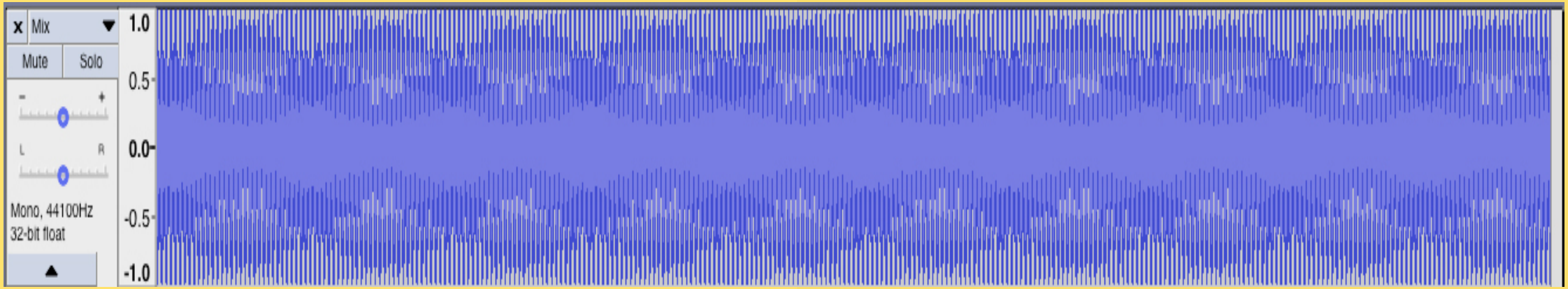
Binaural Beats

Constructive & Destructive Interference

`Generate > Tone 200 Hz` `Generate > Tone > 202 Hz`

`Tracks > Mix > Mix and Render`



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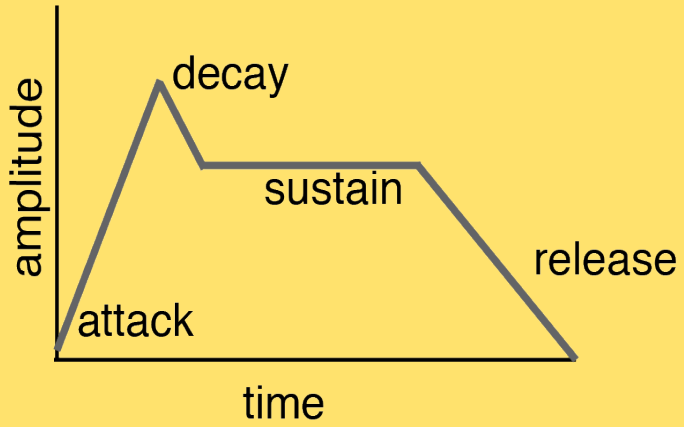
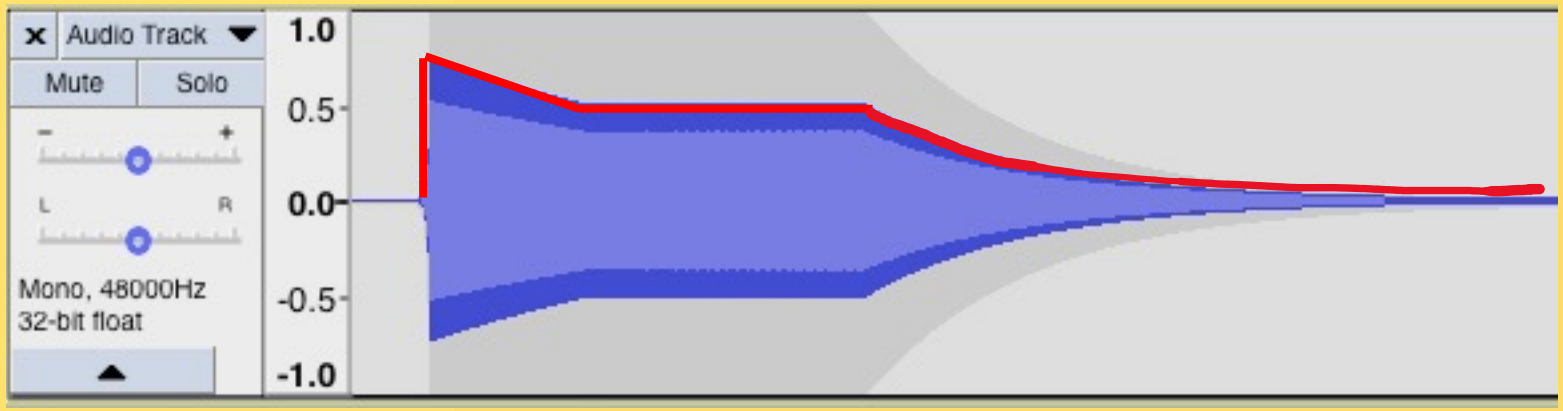
Envelopes



- Attack: how quickly it reaches full volume
- Decay: how quickly it drops to sustain
- Sustain: constant amplitude
- Release: how quickly sound fades away



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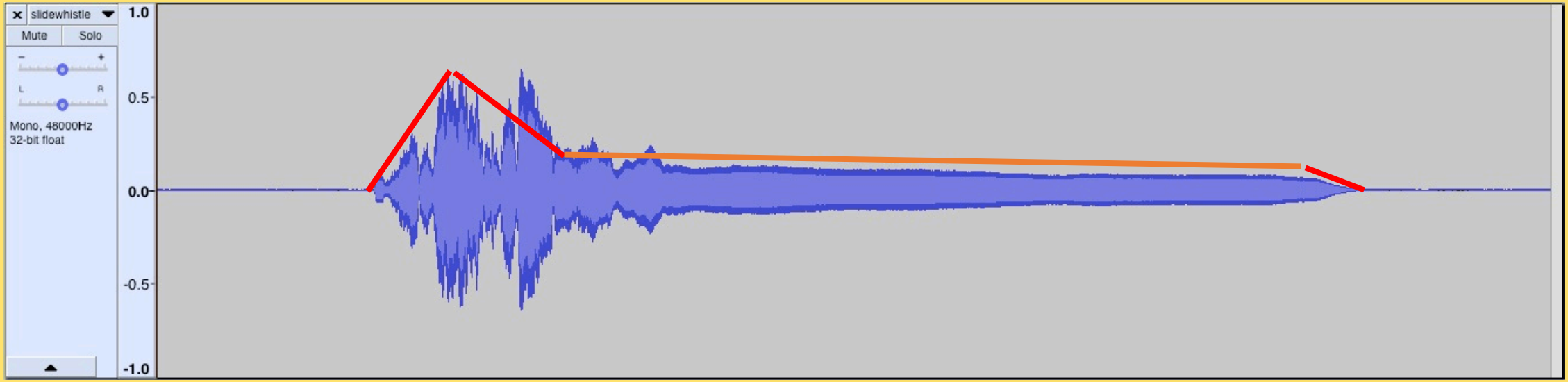
Sound Envelope: Slide Whistle



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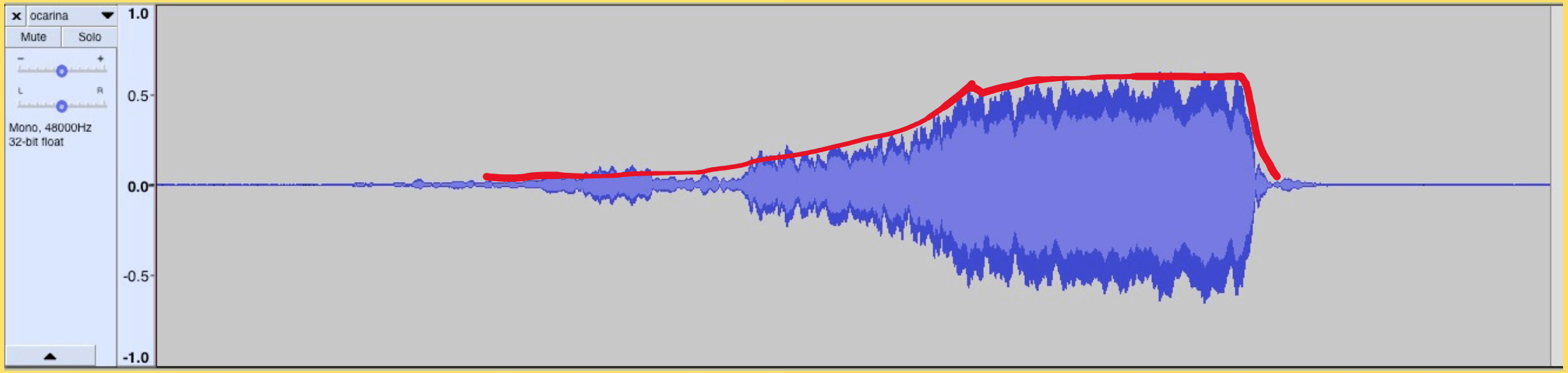
Sound Envelope: Ocarina



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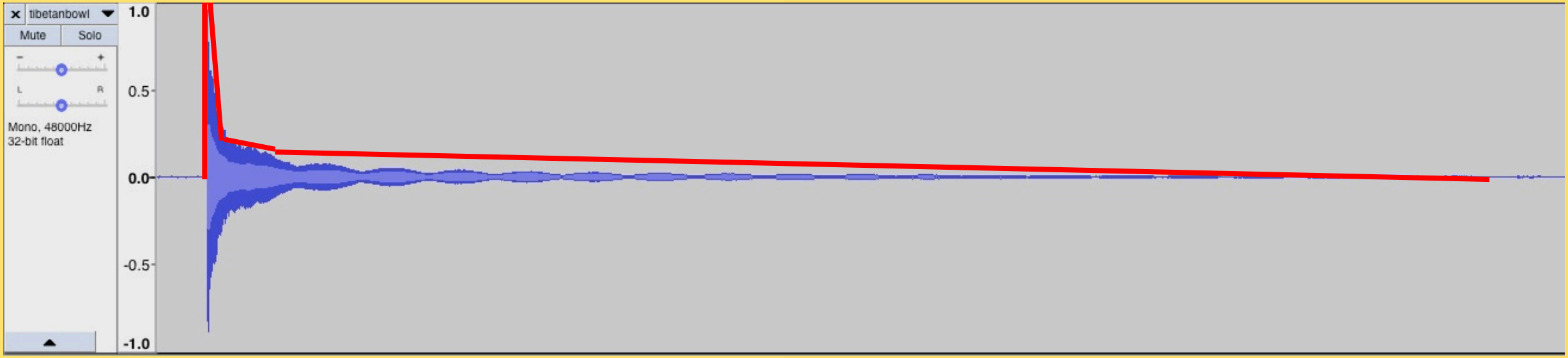
Sound Envelope: Tibetan Bowl



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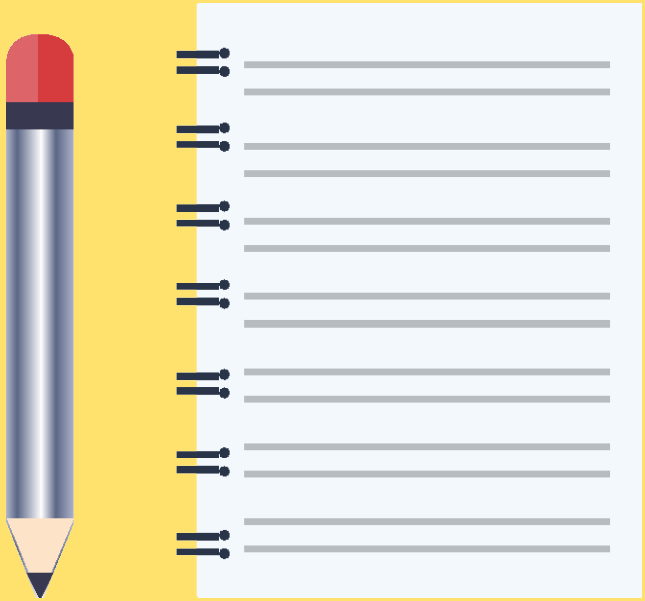
Exercise #2.11 Reverse Envelopes



Reverse a few sounds (Effect > reverse) and note how the envelope of the sound changes. How would you describe the sound you hear now?

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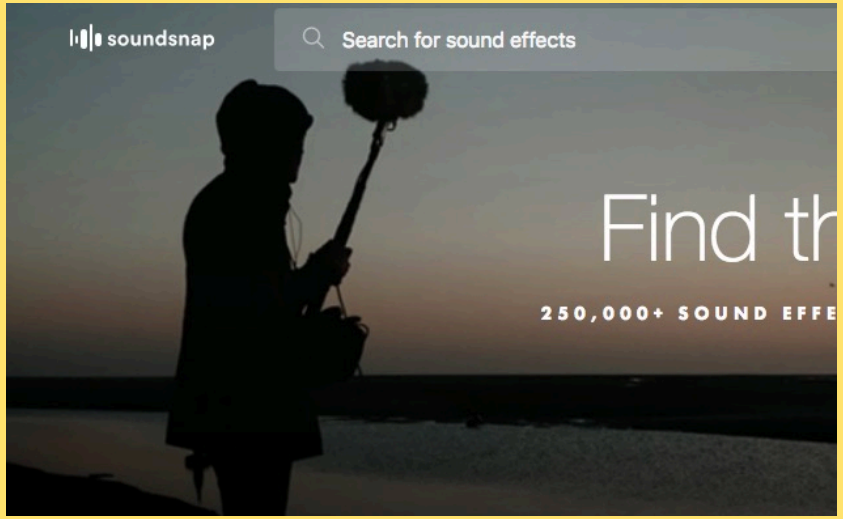
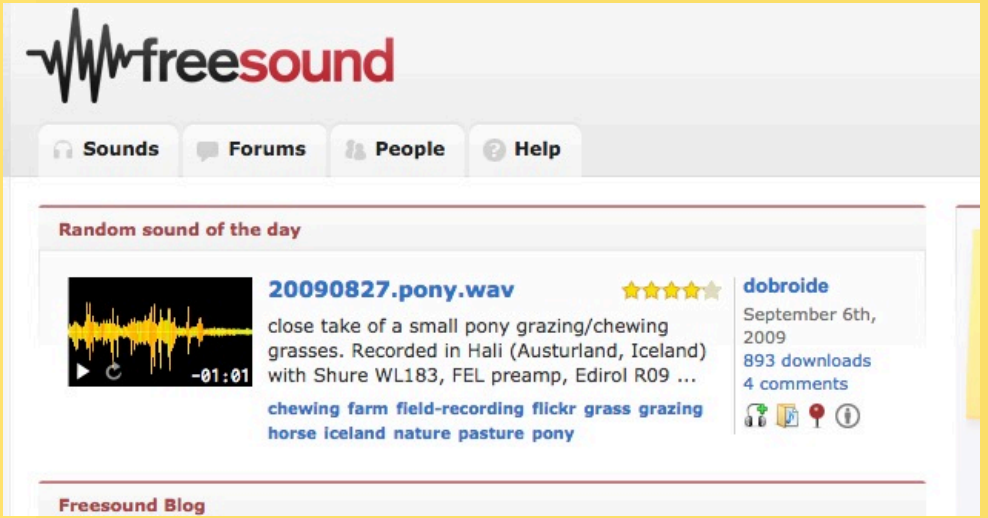
SOUND LIBRARIES





The Wilhelm Scream

https://www.youtube.com/watch?time_continue=1&v=4YDpuA90KEY

https://www.youtube.com/watch?time_continue=1&v=4YDpuA90KEY

Studying Sound

Sound library samples

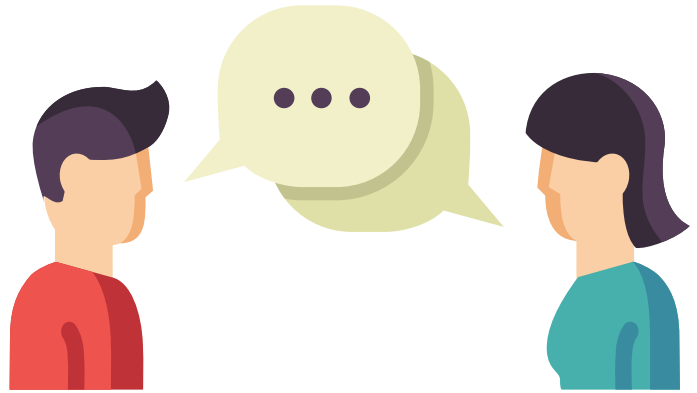
Read the article: https://www.theguardian.com/tv-and-radio/shortcuts/2019/jan/04/where-theres-a-horse-theres-a-neigh-why-must-we-hear-animals-on-screen

Discussion: Is it important to have our own sounds? Why or why not?

SOUND CATEGORIES

- Ambience
- Spot/One-shots
- Foley
- Designed Sounds

- How did YOU categorize sounds?



Studying Sound

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Studying Sound

TRACKING YOUR USE OF SAMPLES

Filename	Source	License
acceleration.wav	https://freesound.org/s/179940/	Attribution
footsteps.wav	https://freesound.org/s/460083/	Attribution non-commercial

Exercise # 2.17 Find a sound like…

Oof

Pop

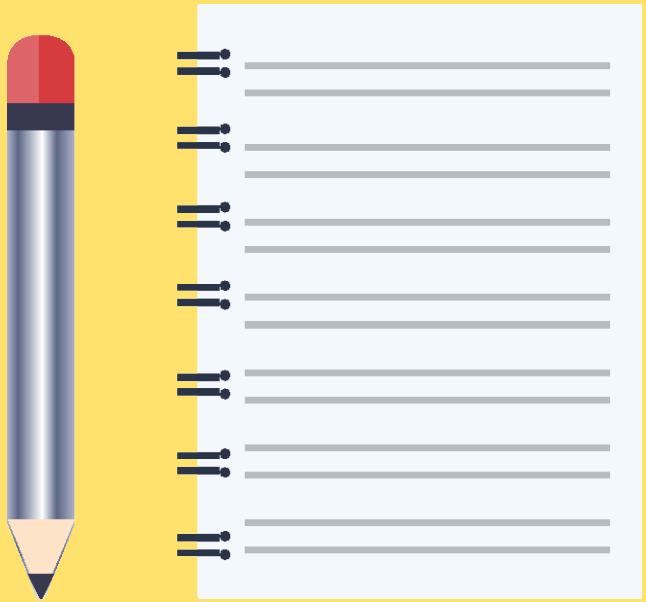
Bang

Whoosh

Swish

Glug

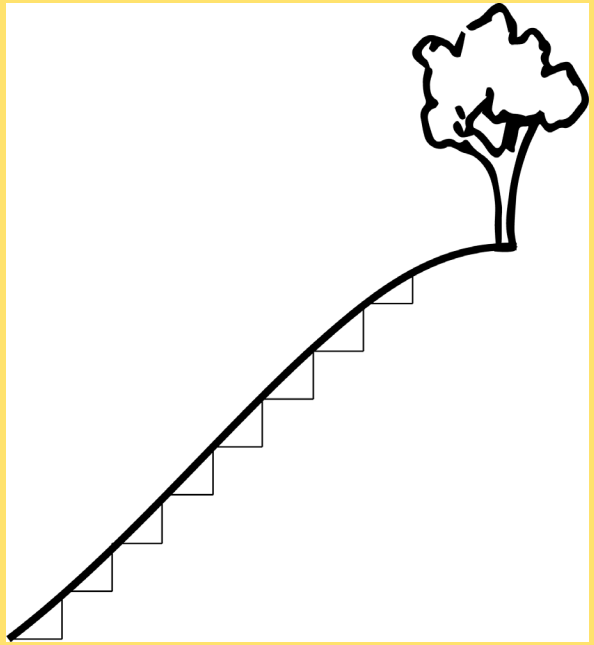
Exercise #2.18 Opposites attract



Find two sounds that appear to be opposites or contrast each other. You can do this with a partner, and one finds a sound and the other finds its opposite. What aspect(s) did you choose to oppose (amplitude? Frequency?)

Studying Sound

DIGITAL SOUNDS



Pulse Code Modulation (PCM)

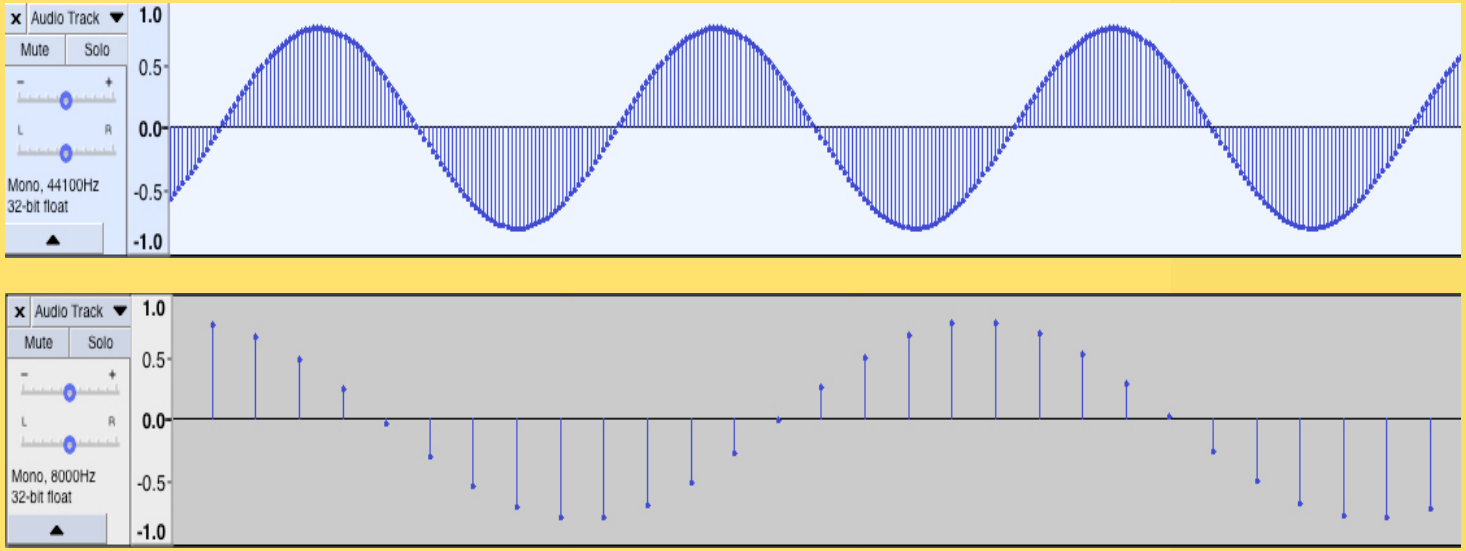
Quantization

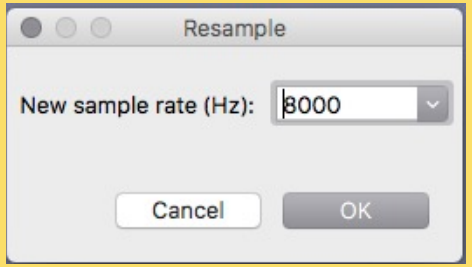
Sampling

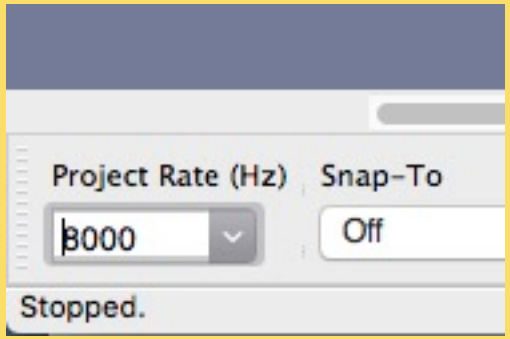
Studying Sound

Sample Rate

`Tracks > Resample > 8000 Hz`



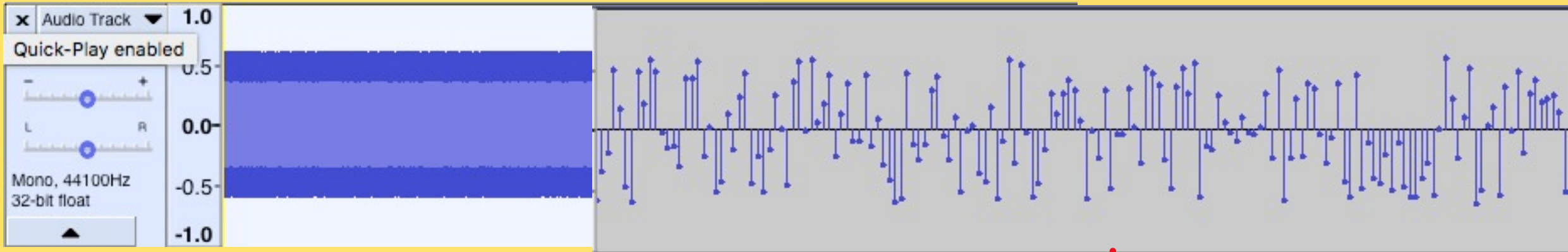




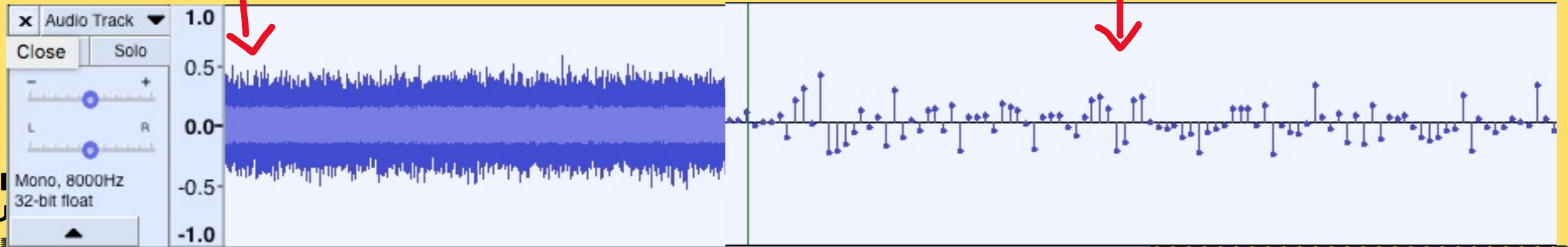
Studying Sound

Noise at 44.1 and 8 KHz

`Generate > Noise > White`



`Tracks > Resample > 8000 Hz`



Bit Depth

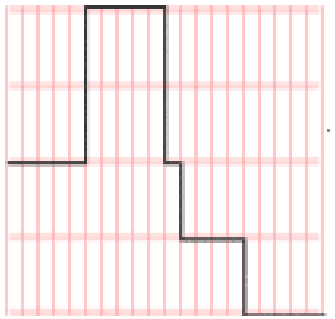


Figure 6 - low bit depth

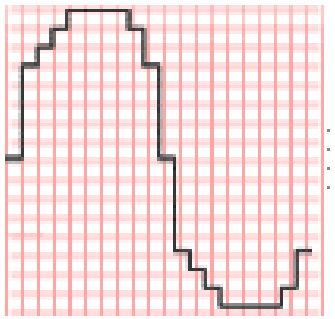
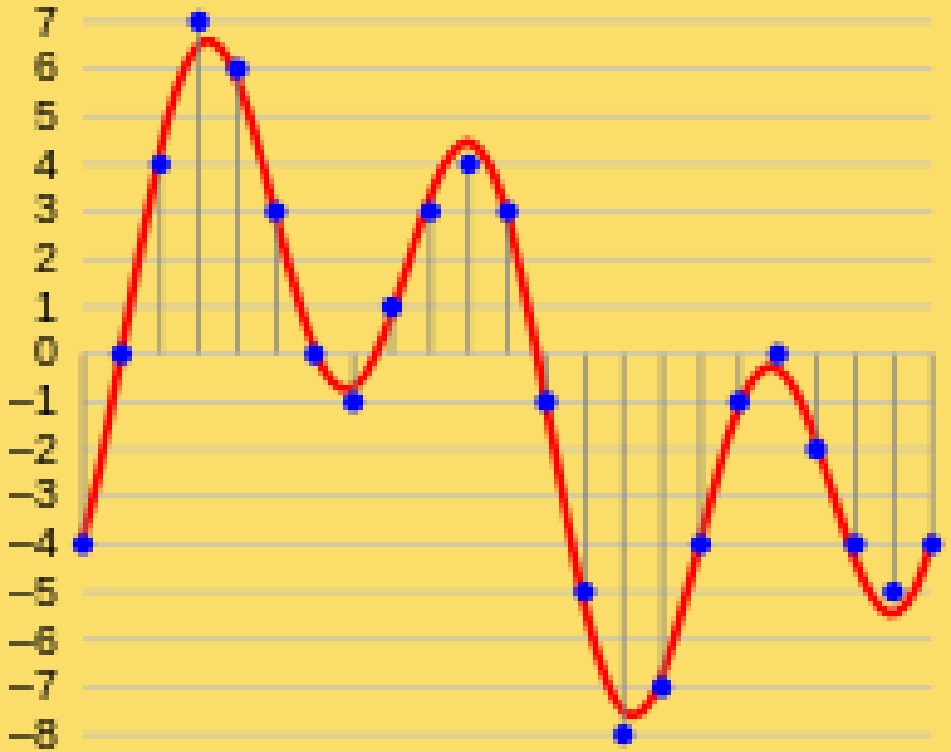


Figure 7 - higher bit depth

https://thehub.musiciansfriend.com/tech-tips/sample-rate-and-bit-depth-an-introduction-to-sampling

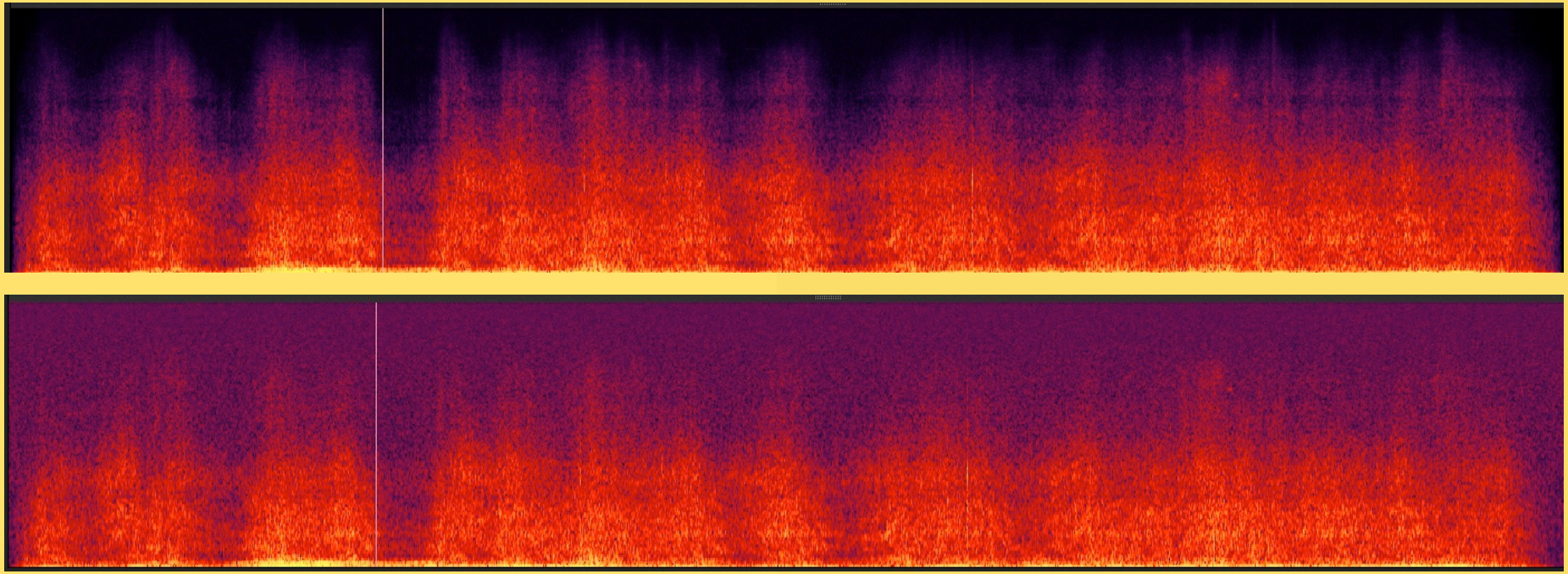


wikipedia

Studying Sound

Bit Depth: Spectral Analysis in Audition

Why is the spectrum on the 8-bit version more grainy?



24-bit

8-bit

Studying Sound

Bit Rate

Measured in Kilo-Bits per second (kbps)

Lossless = 1411 kbps

Spotify Streamed audio = 96 kbps (phones), 160 kbps (desktop)

	CD audio	DVD audio
Sample rate	44.1 KHz	192 KHz
Bit rate	c. 1.5 Mbps	5 Mbps
Bit depth	16-bit	24-bit

Can you hear the difference?

A/B/X Tests:

http://abx.digitalfeed.net/#numTrials/5/sample/0

http://www.mp3ornot.com/

Lossless & Lossy Formats

- LOSSLESS
- No compression
- E.g. .WAV, .FLAC
- 4 minute song ~ 40 MB

- LOSSY
- Varying compression amounts
- E.g. MP3, M4A, OGG, AAC
- 4 minute song ~ 4MB+