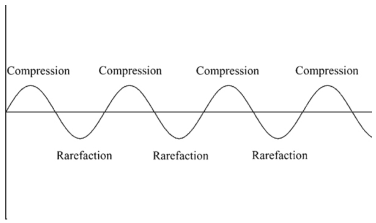
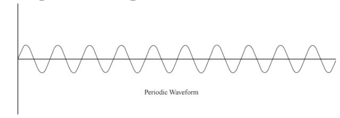
Sound characteristics

- Compressions and Rarefactions
  - molecular disturbances

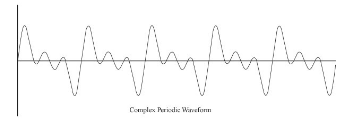


Waveforms

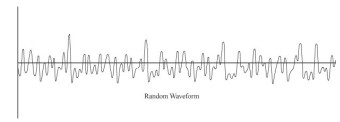
- Periodic



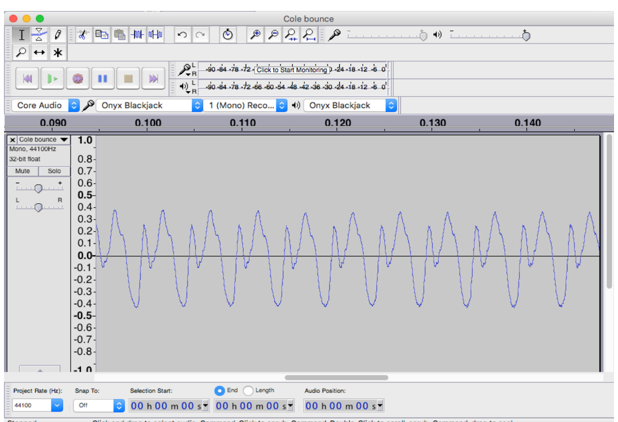
- Complex Periodic



- Random or Aperiodic



Complex periodic: a voice holding a note



Waveform characteristics

- Frequency – Pitch in music – waves per second
- Amplitude – Level or loudness
- Velocity = 1130 fps
- Wavelength – peak to peak in ft
  - Speed / frequency
- Envelope amplitude changes from beginning to end
- Overtones: *(Harmonics, Partials, Formants)*
- Surface Effects & Propagation – bounces

Frequency defined

- Cycles per second (one whole wave = a cycle)
- Also called Hertz
  - 200 Hz is common in a male voice
  - 60 Hz is “hum” from a power line
  - 2500 Hz is where we boost “clarity”
  - 1000 Hz to 4000 Hz our ears are most sensitive

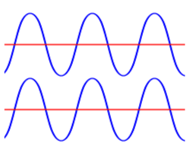
Range of human hearing

- 20 Hz–20,000 Hz or 20 ***k***Hz

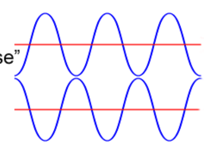
Interference: when two waveforms come together in the air, or in your mixing software.

These examples all have the same frequency.

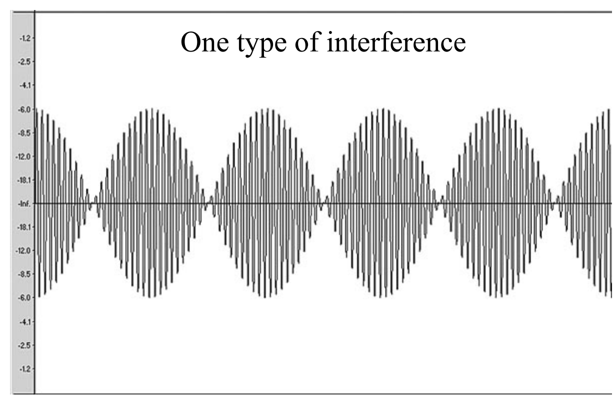
“In-phase” add up



“Out-of-phase” cancel each other out



“Beats”



Occurs when two waveforms with frequencies close but not the same, are mixed, either with actual sounds in air or digitally in a computer.

Constructive and destructive interference

- Interference
  - Two or more sounds at the same time
- Waveform *in phase*: adds volume
- Waveform *out of phase*: subtracts volume
- Common example: sound from a single instrument is recorded by two mics at different distances from the instrument. Sound to one arrives later…
- Result?
  - Some frequencies/harmonics partially cancel and become weak, others are on steroids.

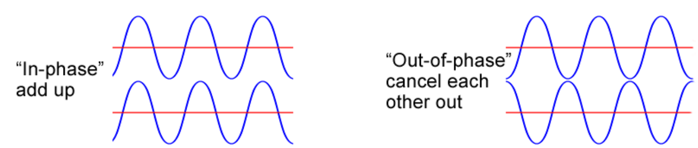
Sources of interference

- More than one *mic* picking up the same sound. (Voice or instrument or Foley)
- A wall or *surface that reflects sound* back to the mic a little later in time.
- Two instruments not quite *tuned* together, or two musicians not quite hitting the same note.

Using the speed of sound

- Speed of sound is 1130 ft/sec *in warm air*
- Why is this important to understand?
  - For example suppose you have two mics picking up the same instrument. One is <u>two feet</u> further away than the other. *Which frequency is going to be canceled when the two tracks are mixed?*
  - Answer…

- Two mics picking up the same instrument.
- One is <u>*two feet*</u> further away than the other.
  - Look for a frequency (hz) that will be out-of-phase.



- The worst case out-of-phase would be 1/2 wavelength off.
- If 2 ft represents 1/2 wavelength, our mystery wave must be *4 ft* long.

- If sound moves 1130 fps, one second of sound is 1130 ft long.
- # of waves in a second? = 1130/4 = ***282.5 hz***
  This frequency will suffer most!

- So C# will not be as loud. Many other related frequencies also.

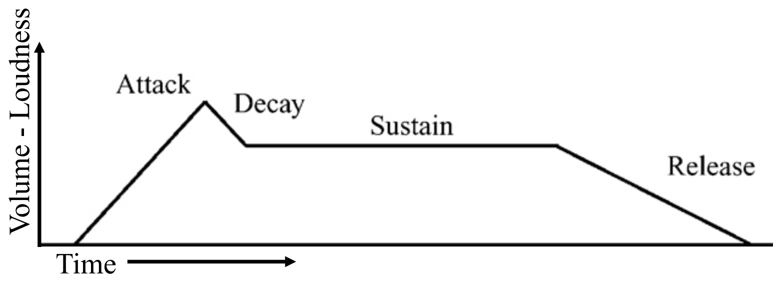
Harmonics/Partials

Fundamental frequency example: 200 Hz

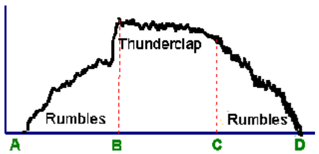
- x 2 = 400 Hz
- x 1.5 = 300 Hz
- x 1.26 = 252 Hz
- x 3 = 600 Hz
- x 4 = 800 Hz
- Etc.…

These are typical harmonics produced by instruments. Dozens would usually be present, all at different amplitudes.

Envelope



Envelope of an “object” sound

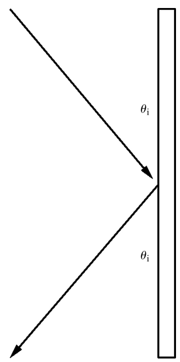


Sound characteristics

- Production
  - Source of the sound
- Propagation
  - Medium through which sound travels
- Reflection and Absorption
  - How it interacts with the space
- Perception
  - Sound receiver and interpreter

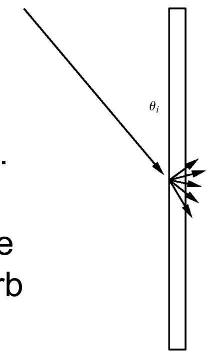
Surface effects

- Reflection from a hard surface like plate glass.



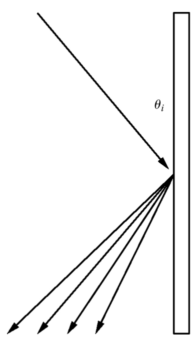
Surface effects

- Absorption from a soft surface like acoustic tile, heavy curtains.
- Higher frequencies are easier to absorb



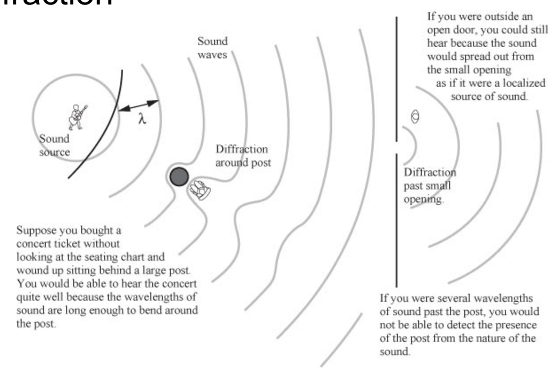
Surface effects

- Diffusion/ Scattering from a rough surface like textured walls.



Surface effects

- Diffraction



A perfect listening room?

- A *perfect listening room* has a *combination* of hard and soft surfaces, and a minimum of walls that are parallel to each other.
- Some reflection is good because it is natural. But reflections that favor certain frequencies are not good.
- Walls that are parallel allow sound to bounce back and fourth between them. Interference will occur and some notes will be louder and some quieter.

A perfect sound editing room?

- A *perfect mixing room* will have *more absorptive* walls with only a few non-parallel reflecting surfaces, and monitor *speakers tuned* to operate in that space.
  - Reflection from a hard surface is efficient. Even with non-parallel walls, the sound stays together and comes back strong and intact as a “delay” or “echo”. If it keeps bouncing back and forth, it will turn to gibberish noise. (Think unfinished basement, or the old Coliseum)
  - Reflection from an irregular hard surface comes back as noise right away, but not as loud.

So what is a perfect room?

- Speaker placement and adjustment are important
- “Table top resonance”. Any hard surface reflects sound, including the one you put your speakers on. You may hear the tweeter sounds twice, once direct, and once a little later after it bounces off the table top. Interference!
- Plus the table top might vibrate on certain frequencies. That will add level to those frequencies.
- Speakers against a wall have 2x bass levels.
- In a corner they have 4x bass levels.
  - So are you really hearing *your* bass level mix?

Decibels and Intensity

- ***dB*** is 1/10 of a Bel. OK so what is <u>that</u>?
  - A ratio that helps compare one sound to another,
  - Describes relative “intensity” or magnitude,
  - Describes sound in a way that “sounds right” and that matches what our ears perceive.
- Who cares? You! Used for all <u>editing controls</u>!
  - ***1*** *dB is about the smallest change we can hear.*
  - ***2*** *dB change we would notice without being told.*
  - ***3*** *dB+ increase in sound system volume requires a doubling of power from the amplifier.*
  - ***6*** *dB decrease is perceived to be twice as far away.*
  - ***10*** *dB+ is perceived to be about twice as loud*
  - ***.5*** *db can change the character of a* ***mix*** *dramatically.*

Hardware: A *Different* dB Scale

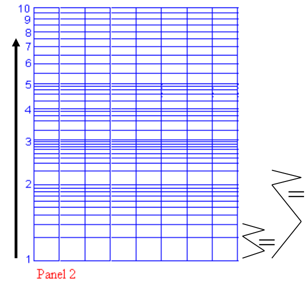
dBv and dBu are used to identify inputs - outputs

- An **input** is a connection that allows a signal to be brought in.
- An **output** is a connection that sends the signal to another piece of equipment.

- Why care? To avoid clipping and noise.
- Pro mixing hardware inputs and outputs are marked in dB Must be matched to other equipment to work best.
  - ***+4 dBv*** *or about 1.5 volts RMS (main mixer outputs)*
    - *(V indicates compared to 1 volt, old telephone line standard)*
  - *+4 dBu or about 1.228 volts RMS*
    - *(U indicates compared to .775 volts)*
  - ***-10 dB*** *is about .316 volts RMS (your stereo left and right inputs)*
  - ***-40 dB*** *microphone level*

dB use a “log” scale

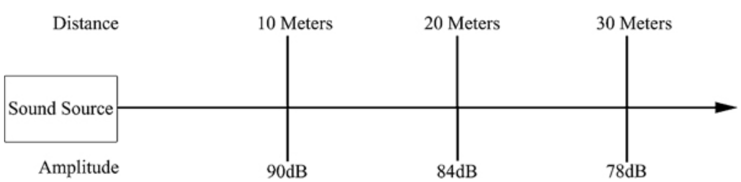
*Logarithm.



Each horizontal line represents the same amount of *energy* as the one below it.

The difference in ***energy*** between 1 and 2 db is equaled by the difference between 2 and 2.1 db (approximately) and so on up the scale. But to our ***ears***, the ***difference in loudness between 1 and 2 db or between 2 and 3 db is about the same***.

The law of conservation of energy in dBs



Typical dB Levels in Life

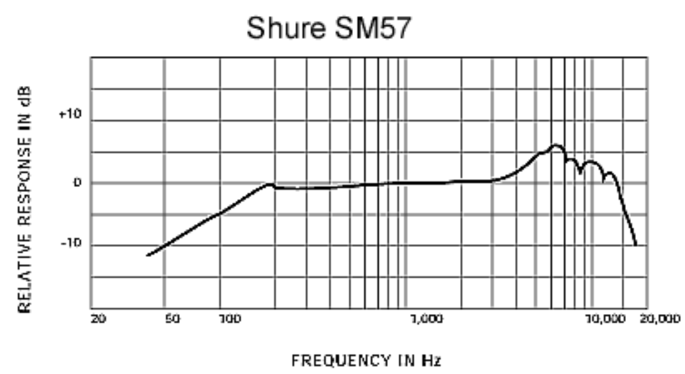
- 0 dB
- 10 dB
- 40 dB
- 50 dB
- 60 dB
- 80 dB
- 110 dB

- No sound
- Breathing
- Whisper @ 4’
- Office ambience
- Conversation @ 4’
- Family car passing
- Loud band

Level Meters
RMS vs Peak

- RMS is “root mean squared”
  - Kind of a realistic average level
- Peak is quick and particular
  - No clipping can slip by undetected
- In amplifier ratings
  - RMS = 0.707 x Peak Values of a sine wave amplitude
  - Considered an realistic way to measure intensity or power delivered

Frequency response chart



Tool for changing frequency response
(Audacity EQ tool)