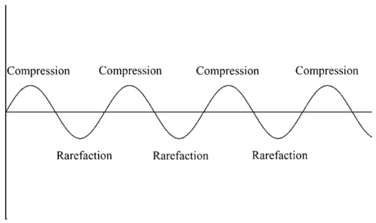
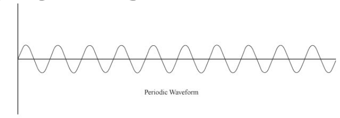
Sound characteristics

- Compressions and Rarefactions
  - molecular disturbances

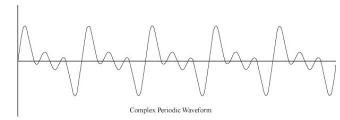


Waveforms

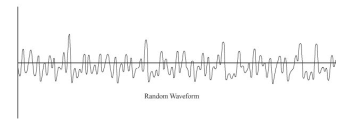
- Periodic



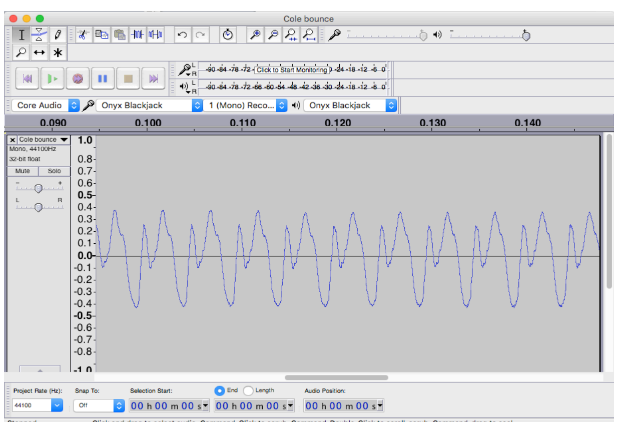
- Complex Periodic



- 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

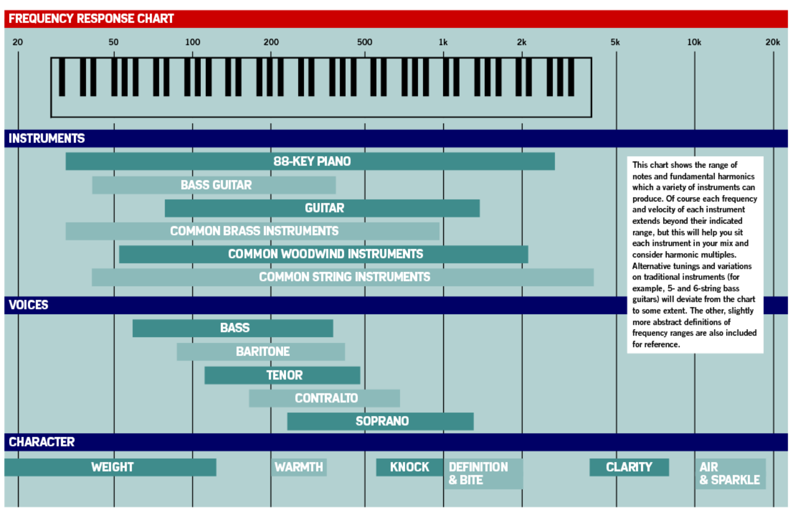
Frequency defined

- 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

Ranges of Frequencies of Instruments and Voices

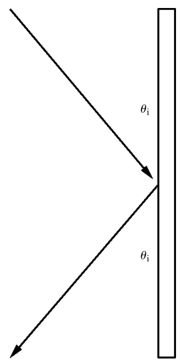


Sound characteristics

- 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

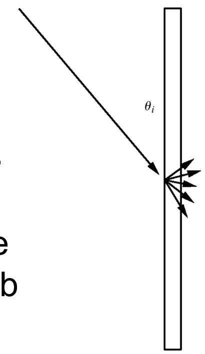
Surface effects

- Reflection from a hard surface like plate glass.



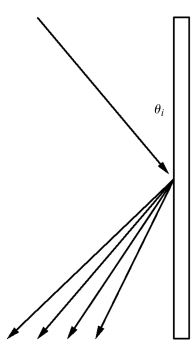
Surface effects

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



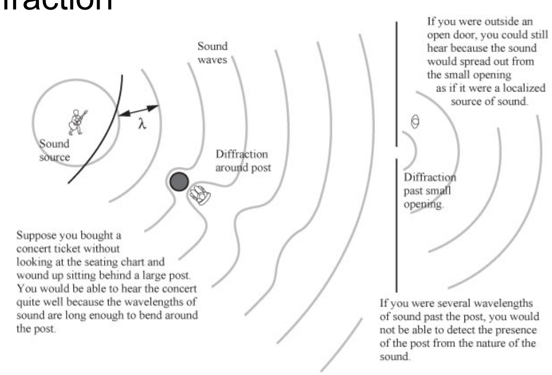
Surface effects

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



Surface effects

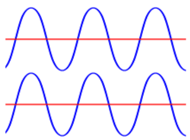
- Diffraction



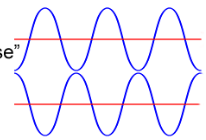
Interference: when two waveforms come together in the air, or in your mixing software.

These examples all have the same frequency.

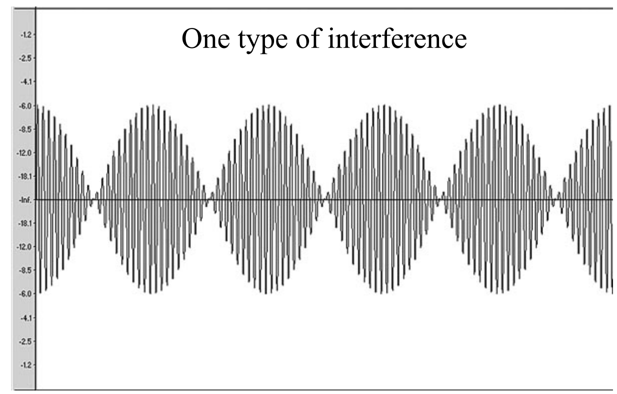
“In-phase” add up



“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.

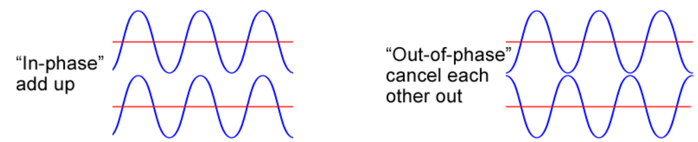
Sources of interference

- 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 *two feet* 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 *two feet* 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.

Resonance

- A tendency of sound to bounce back and forth in an enclosure, and through interference, favor certain frequencies so they become more intense.
  - Pipe organ - Horn
  - Guitar body - Room
  - Speaker port

Resonance Room Example

- 40' x 50' x 10' room
- These notes might resonate

- 1130 fps/40 f = 28.5 hz (also 56, 113, 226, etc.)
- 1130 fps/40 f = 23 Hz (also 46, 92, 184, etc.)
- 1130 fps/10 f = 113 Hz (also 226, 452, 904, etc.)

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?