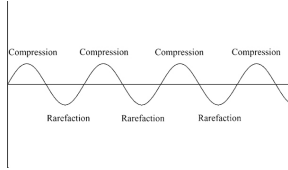


## Sound Characteristics

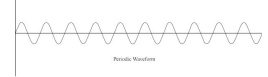
- Compressions and Rarefactions
  - molecular disturbances



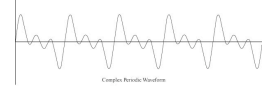
1

## Waveforms

- Periodic



- Complex Periodic



- Random or Aperiodic



2

## Sound Characteristics

- Production
  - Source of the sound
- Propagation
  - Medium through which sound travels
- Perception
  - Sound receiver and interpreter

3

## Waveform Characteristics

- Frequency - Pitch
- Amplitude - Loudness
- Wavelength
- Velocity
- Envelope
- Overtones: (*Harmonics, Partial, Formants*)
- Surface Effects and Propagation

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## Frequency Defined

- Cycles
- Hertz - cycles per second

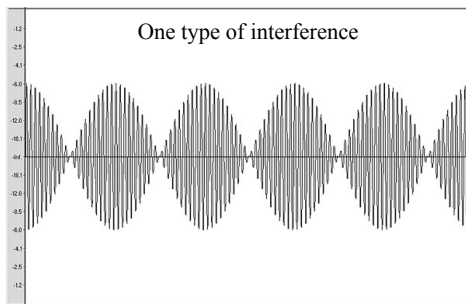
5

## Range of Human Hearing

- 20 Hz–20,000 Hz or 20 kHz

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## “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.

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## 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.
- Two similar waveforms “out of phase.”

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## Constructive and Deconstructive Interference

- Interference
  - Two or more sounds at the same time
- In Phase: adds volume
- Out of Phase: subtracts volume
- Common example: sound from a single instrument is recorded by two mics at different distances from the instrument.
- Result?
  - Some harmonics/partials gone, others on steroids.

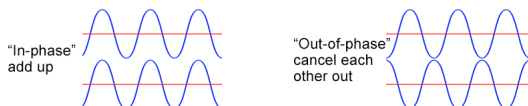
9

## Using the Speed of Sound

- Speed of sound is 344 m/sec or 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 murdered when the two tracks are mixed?*

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- 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 is 4 ft long.
- Remember: “One second of sound is 1130 ft long.”
- # of mystery waves in a second? =  $1130/4 = 282.5$  hz
- That frequency will suffer most!
- (+ related harmonics & close freqs too!)

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## Harmonics/Partial

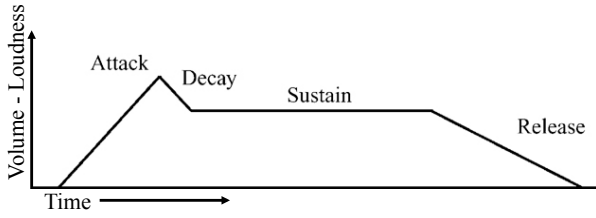
Fundamental Frequency (example): 200 Hz

- 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.*

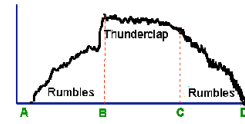
12

## Envelope



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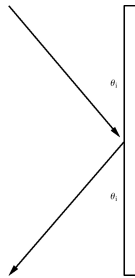
## Envelope of an "Object" Sound



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## Surface Effects

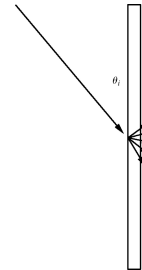
- Reflection from a hard surface like plate glass.



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## Surface Effects

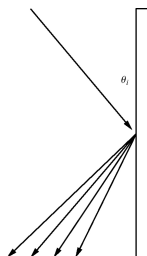
- Absorption from a soft surface like acoustic tile, heavy curtains.



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## Surface Effects

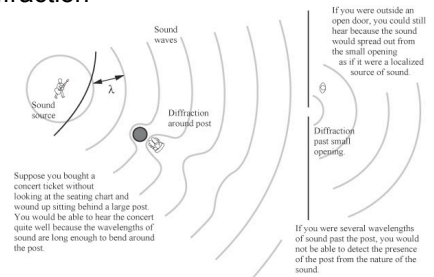
- Diffusion/Scattering from a rough surface like textured walls.



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## Surface Effects

- Diffraction



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## So What is a Perfect Room?

- A *perfect listening room* has a *combination* of hard and soft surfaces, and a minimum of walls that are parallel to each other.
- 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. 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, the old Coliseum)
  - Reflection from an irregular hard surface comes back as noise right away, but not as loud.
- Table top resonance. Any hard surface reflects sound.

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## Decibels and Intensity

**dB** is 1/10 of a Bel

- 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? The standard unit for all mixing!
  - **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.
  - **10 dB** is perceived to be about twice as loud
  - **.5 db** can change the character of a *mix* dramatically.

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## Decibels and Hardware

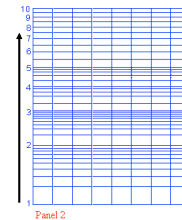
**dBv and dBu are used to identify inputs - outputs**

- 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? Pro mixing hardware inputs and outputs are marked. 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

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## dB use a “log”\* scale

\*Logarithm.

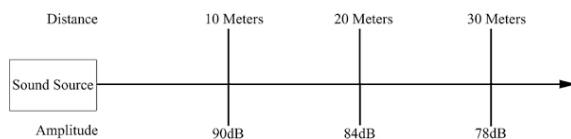


Each horizontal line represents the same amount of *energy* as the one below it.

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.*

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## The Law of Conservation of Energy



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## “Period” Defined

- The *time* for one full wave(length) to arrive
- Time = 1 / Frequency

Example: 800 hz sound

$T = 1/800 = .00125$  sec for one full wave

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Determining Frequency when velocity and wavelength are given

- $F = \text{Velocity} / \text{Wavelength}$

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## Amplitude Defined

- Pressure compared to atmospheric pressure

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## Root Mean Squared (RMS)

- $\text{RMS} = 0.707 \times \text{Peak Values of a sine wave amplitude}$
- Considered an realistic (honest) way to measure intensity or power delivered

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