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Learning Outcomes

- Understand how waveforms, spectra and spectrograms can be use to view sound signals.

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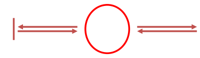
Characteristics of Sound

1. Amplitude of displacement

Sound Force

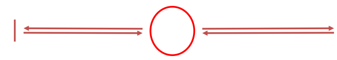
Air molecule

- maximum displacement



+ maximum displacement

QUIET SOUND – SMALL DISPLACEMENT



LOUD SOUND – LARGE DISPLACEMENT

(rather than air molecule displacement we usually talk about sound pressure as the measure of sound amplitude)

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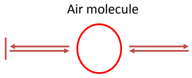
Characteristics of Sound

2. Period (T)

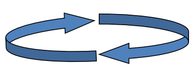
unit of measure: seconds (s)

Air molecule

- maximum displacement



+ maximum displacement



period (T) = time taken to complete one cycle

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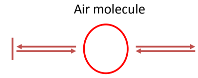
Characteristics of Sound

3. Frequency (f)

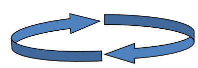
- unit of measure: Hertz (Hz)
- 1 Hz = 1cps

Air molecule

- maximum displacement



+ maximum displacement



frequency (f) = number of cycles per second

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Period & Frequency

- Period = time required to complete one cycle (seconds per cycle)
- Equations: $T = 1/f$, or $f = 1/T$
- Thus frequency (f) and period (T) are related
- It is an inverse relationship: the larger the period, the slower the cycle, and the fewer cycles per second

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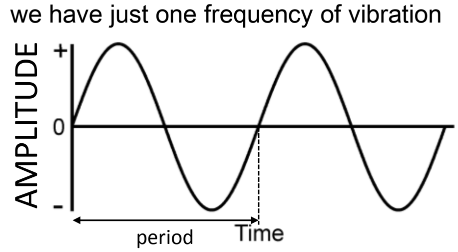
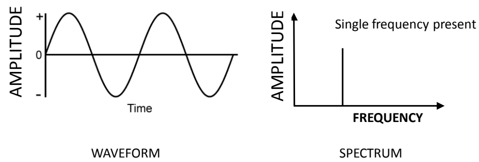
Sine Wave

- If we have a single 'pure-tone' whistle then we have just one frequency of vibration



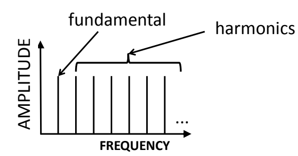
Spectrum

- We can represent the frequency on a spectrum

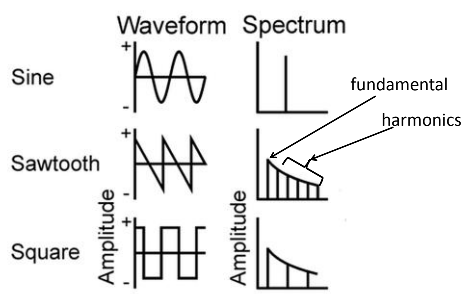


Complex periodic sounds

- Complex periodic sounds have a repetition frequency (fundamental) and higher frequency components at multiples of the fundamental (harmonics)



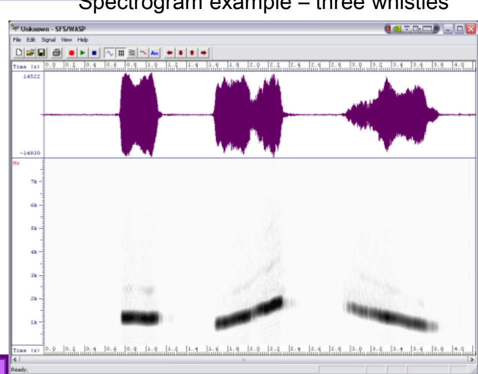
Complex periodic sounds

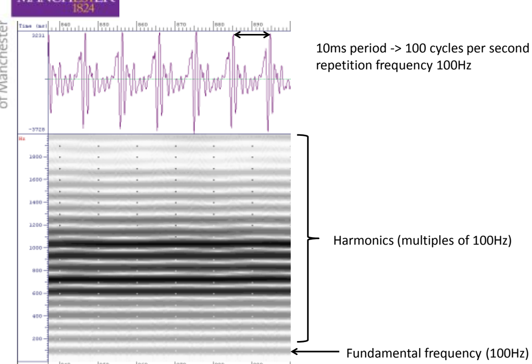


Spectrograms

- To view the changes in the speech spectrum through time we use a spectrogram
- This shows the acoustic energy at each frequency and time
- The darker the display, the more energy is present at that frequency
- Allows us to view the dynamic changes in the speech spectrum

Spectrogram example – three whistles





Spectrogram Bandwidth

- Wide-band spectrogram – coarse frequency resolution (smears detail across frequency), rapid time response
- Narrow-band spectrogram – good frequency resolution, poor time-response (smears detail across time)