

Waves and Sound 2013- Lesson Plans

- Estimated time required: 75 minutes
- Target group size: 10-15
- Target grade level: 9-12
- **Summary of activity**
 - Students will learn about the relationships of the core components of sine waves. Using custom iOS applications, students are introduced to time and frequency plots for different types of waveforms in order to see and hear how multiple sinusoids comprise any type of sound wave. Students will explore drawing their own waveforms and recreating those waveforms based on their acquired knowledge of frequency, amplitude and harmonics.
- **Pre-requisite knowledge requirements**
 - Math: Understanding of plotting on the XY axes, multiples of integers
 - Science: None
 - Music: None
 - Other: None
- **Dependencies on other SMT activities**
 - Does it need to come after one of the other activities?
 - No
- **Learning objectives**
 - After this lesson, students should be able to...
 - Explain what sound is based on a specific example (voice, instrument, etc.)
 - Describe the concepts and relationships of the parameters of a sine wave (amplitude, wavelength, period, frequency).
 - Create a sound from a sum of sinusoids with information from the FFT
 - Explain and find harmonics of a wave
- **Relevant educational standards**
 - Math: 2.10 Trigonometry
 - Science: 3.7 Technological Devices
- **List of materials for each station**
 - Each station needs:
 - 1 iPad (loaded w/ Waves & Sound and SoundSynth apps)
 - 1 pair of headphones
 - Activity Sheets
 - Pen/pencil

- **Detailed description of the activity**
 1. Introduction / motivation
 - What is sound?
 - Give examples where sound is used in real-world situations that relate to engineering (speaker recognition/forensics)
 2. Background
 - Sound is the change in pressure inside the ear
 - Sound travels through solid, liquids and gases by creating vibrations in the molecules
 3. New Vocabulary / Definitions
 - **Cycle:** one repetition of a waves pattern
 - **Frequency:** the number of cycles per second (measured in hertz (Hz))
 - **Period:** time duration of one cycle of a wave
 - **Wavelength:** the length of one period of a wave
 - **Fundamental Frequency:** the lowest frequency of a sound (harmonic series) and usually the most dominant frequency
 - **Harmonic:** integer multiple of the fundamental frequency
 4. Procedure
 - Before the activity:
 - Make sure that iPads are working and are loaded with the necessary applications.
 - Hand out the worksheet
 - With the students:
 - **Part 1: Sine Waves and Waveforms**
 - Students are introduce to the components of a sine wave
 - Fill in blanks for questions asking about the relationship of these parameters.
 - Students explore the Waves & Sound application to hear and see the difference between sine, saw, and square waves
 - Students will manipulate fundamental frequency and amplitude and note how the signal changes in the FFT

- **Part 2: Signal Analysis on iPad**
 - Students will set fundamental frequencies of different waveforms and identify peaks beyond this frequency
 - Core concept of harmonics being multiples of the fundamental frequency are introduced
 - Students will recreate waveforms using information from the Waves & Sound FFT and plotting that data in SoundSynth. Audio and visual similarities and differences are noted.
 - As an assessment, a “Harmonics Game” will be played where students must display their knowledge of harmonics and different waveforms.
- 5. Safety Issues?
 - Playing sounds extremely loud is not the best for the ears
- 6. Troubleshooting tips
 - Make sure students have a firm grasp of the 2 displays (waveform and frequency spectrum before moving onto the “Draw your own waveform” task)